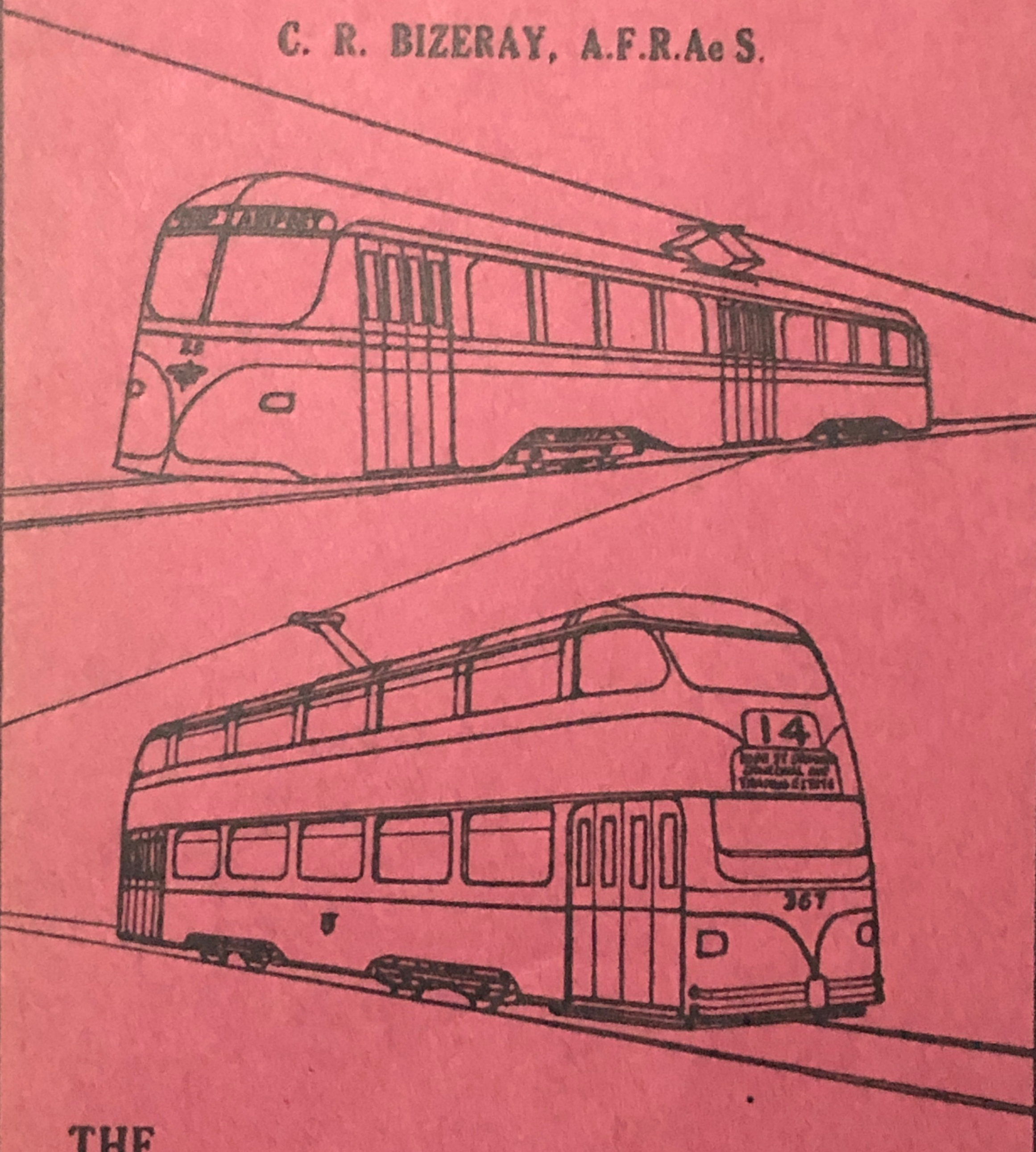
TOWARDS IDEAL TRANSPORT

In Town Planning and Reconstruction.

C. R. BIZERAY, A.F.R.Ae S.



THE
LIGHT RAILWAY TRANSPORT LEAGUE.

TOWARDS IDEAL TRANSPORT.

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Special P.C.C. Car for Chicago Surface Lines, Ill., U.S.A. (One of the largest Tramway Systems in the world.)

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Towards Ideal Transport in Town Planning and Reconstruction.

I. The Functions of Urban Transport.

AS the war slowly moves to its inevitable conclusion, so does interest in planning a better aftermath increase, indeed, few subjects are more prominent in the public mind. Not only has the devastation of cities rendered necessary reconstruction on a scale unparallelled in all history, but while progress in many of the civil arts and sciences has been halted, other sociological and technical innovations have undergone intensive development. Many of these latter will ultimately exert a profound influence on the whole pattern of community life, when no longer restricted by military necessity; we shall be enabled not merely to improve existing practices, but to advance our civilisation to altogether new standards. A rare and major opportunity thus occurs to re-plan for greater efficiency, comfort and prosperity, with lasting benefit to all our people.

Where urban life is concerned, post-war reconstruction divides into two broad but closely-related categories:—

(1) The rebuilding of existing cities, to reduce congestion partly by de-centralising portions of their populations, and partly by gathering the remainder into taller buildings sited in the original districts.

(2) The establishment of new suburbs and satellite towns to accommodate people thus displaced.

The former appears to present the more complex problems, since the ideals of the new must shoulder their way in amongst the institutions and traditions of the old, and largely displace them. Varying land values and equitable compensation present many knots to unravel. Some industries are tied by their essential technical processes to certain districts, which may be anything but ideal for their employees to live in. Others will demand room for expansion to an extent which may jeopardise the most careful pre-planning. New inventions and discoveries tend to develop new trades and contract older ones, causing fluctuations in prosperity which will be reflected in local migrations of population. The general speeding-up which is characteristic of this present age subconsciously implants a restlessness in many people, who find solace only in movement. Some, albeit a minority, will always wish to exercise to the full their democratic right to live in a locality of their own choosing,

and demonstrate their individual initiative; who would gainsay this peculiarly British trait of independence, which stood us, and, indeed, the whole world, in such good stead in 1940?

This last aspect, still vivid in our minds, compels the reflection that a large measure of dispersal, both for industries and populations, may prove of permanent value. After the last war, most of the new light industries settled around London, partly because of its obvious value as a large and prosperous sales-market, partly because of its size as a reservoir of labour, and partly because of the much more numerous and varied entertainments and social amenities presented by the capital city to a newly-arisen type of young industrialist making money quickly. An interesting and instructive index to the latter was sometimes provided in the lists of people apprehended by the police in night-club raids! London prospered—at the expense of the North. Not until the swastika cast its shadow was this migration forcibly reversed, but there still remains a twenty-year accumulation of sprawling overgrowth, which, lacking cohesive girdle transport, adds to central congestion rather than relieves it.

Even acknowledged experts propound different solutions. For example, the London County Council's recently-published plan for London envisages a preponderance of flats, in order to use the available central-area ground most economically and reduce the costs of essential public services by shortening the distances over which they have to be distributed. In some quarters, rosy but unfounded optimism has gone far enough to publicise the assumption that most of the inhabitants will "get anywhere by fast bus or car within ten minutes." Large blocks of flats, however, imply large concentrations of people, and auxilliary *vertical* transport in the form of lifts, apart from the question of orthodox horizontal transport, which factual experience and statistics suggest requires intensive services of capacious public vehicles, if reasonable economies of space and cost are to be considered.

On the other hand, many eminent critics have expressed a preference for a major proportion of houses, for better health of both body and mind. This policy implies a greater built-up area, which will in turn require a network of fast, frequent public transport routes to knit it together. It must be remembered that people will not only travel to concentrate at places of employment, but also at theatres, cinemas, football and boxing matches, concerts, races, etc. In any sphere, genius will always attract more than mediocrity; the common man flocks to witness it, and creates a demand for a means of transit.

It is commonly said that "Transport is Civilisation," but rather should we subordinate the former to the requirements of the latter, in order to live our lives to the fullest measure; our journeyings must be but a means to that end. Transport is the essential link between home, work and recreation; its modern forms can make possible a planning of all three in the varying

localities best suited to their respective needs. Such transport must, however, combine the attributes of safety, regularity, comfort, speed and cheapness.

The first and second attributes are closely allied, and must be virtually 100 per cent; even a reduction of 1 per cent. is sometimes sufficient to condemn a service in practice. Comfort, however, is largely a matter of detail design; the extent to which it is provided usually depends on the journey duration of any particular type of vehicle. In each category there are certain good modern standards which meet the susceptibilities of the average passenger; it is generally uneconomic to go beyond, but in the case of vehicles running on rails these afford a level basic platform which should prove an inherent advantage for smooth, vibrationless travelling.

Speed is of ever-increasing importance. Emphasised by modern aircraft performance, it is no less valuable for the mundane but infinitely more numerous journeys made every day by urban people, particularly in travelling to and from their places of employment. London Transport estimates that ten million passengers use its services daily. A saving of ten minutes per passenger in waiting and journey times would therefore yield ten million hours in a six-day week. At an average rate of 2/- per hour this represents a potential saving of £50,000,000 per annum for the London area alone, and justifies considerable capital expenditure on means to effect it. As machines continue to multiply in the service of man, so will his time increase in value; a tendency which would be accelerated by any appreciable decrease in the nation's birthrate.

Equally essential is cheapness, in the sense of profitable operation at low fares; this can be achieved only if the forms of transport selected are basically the cheapest in their respective spheres of operation. Such a policy demands firm, impartial and well-advised administration, particularly where sectional interests preach to an ill-informed public, otherwise the most well-intentioned unification of services may have its proper development frustrated.

Short-sighted short-term policies may then be adroitly imposed, and "co-ordination" prove an expensive mockery. London's transport is the dearest of any capital city in the world; its outer suburbs require single fares of a shilling and more to reach them by any form of public conveyance excepting tramcars, thus constituting a heavy burden on most of its citizens. Were the Londoner less prosperous—and less trustful—he might well ask why his counterpart abroad travels as far and farther for a fraction of the fare he pays himself; or, indeed, why his cousins in some of our own great provincial cities such as Glasgow, Liverpool, Leeds and Sheffield are carried from centre to boundary for a modest twopence or threepence, or their children reach country surroundings for a fare as low as a halfpenny in some cases. The less anyone requires to spend on fares, the greater the amount of income available to spend

on other necessities of life, not to mention luxuries and amusements.

There are certain other salient points to be considered. Even in peace-time, from 60 per cent. to 90 per cent of people journeying in any city use public transport vehicles; the present restrictions on private motoring have increased this figure to about 95 per cent. Again, whereas only a minority of pedestrians are motorists, virtually 100 per cent. of motorists, cyclists, passengers, etc., are pedestrians at certain times. A further point is that automobiles occupy on an average six times as much road space as buses and eight times as much as trams for the same number of people carried. The war has resulted in the almost complete disappearance of the private automobile—and a corresponding disappearance of traffic congestion.

Clearly, then, the two classes of people most entitled to priority consideration in urban transport policies are public-vehicle passengers and pedestrians; this implies good all-round services for the former with complete safety for the latter. Since the transport installations can be as permanent as the buildings they serve, economy demands that their equipment be also "built-in," and financed by a compatible long-term policy to yield the best results. For the main routes at least, electricity from a centralised source is widely regarded as the best motive power, for cleanliness, quietness, rapid acceleration and ease of control. Whether derived from coal-fuel generating stations, or from hydraulic power, or eventually from atomic sources, the same distributive methods will serve, and the quality remain constant. Equally evident is the need for canalisation or segregation, to ensure safety at high speed together with economical usage of space for all degrees of traffic density; this can be effected with mechanical precision only if the vehicles are operated on rails.

The requirement of segregation, however, must not overshadow that of accessibility. Passengers should not have to make a lengthy and inconvenient ramble to reach their transport service; on the contrary, it should be brought as near as possible to them. This implies in general a proximity to roads, because these are the elementary and universal means of physical communication, constituting feeders and distributors for all other systems. Finally, the service must, so far as it is possible, be "on tap," or frequent enough to obviate time wasted by waiting at boarding-points. This means the operation of short units almost continuously, rather than long units intermittently The desirable characteristics would therefore seem to be: (1) Electric propulsion; (2) Operation on rails; (3) Ease of access; (4) Frequency of service.

Thus the ideal transport vehicle emerges in the form of an electrically-driven railcoach, operating along or adjacent to a highway. In principle, it is a tram. In practice, it can embody all that modern science and engineering has to offer, not only in detail design, but also in disposition of route. Let us,therefore,

examine this type of vehicle more closely, and compare it with the various alternative means of local public transport, in the light of actual facts.

II. Primary Governing Factors.

Two main considerations govern the operation of urban passenger transport.

(A) The economic factor of sufficient load.

(B) The technical factor of route disposition.

It will be shown later that favourable changes in (B) are capable of influencing (A) to an extent not generally appreciated, but of the utmost importance in connection with town planning. In the past, these factors have all too often conflicted with one another.

(A) SUFFICIENT LOAD.

The degree and nature of the load to be carried determines the proportion of fixed equipment for maximum economy. This divides into three main stages:—

(1) Operation of rubber-tyred steerable vehicles with self-contained power units; *i.e.*, motor-buses. These are most suitable for infrequent, occasional or otherwise lightly-loaded services, or for pioneering new routes.

(2) Replacement of the self-contained power-unit by one deriving its power from a centralised source. Generally, this is justified when the average service headway is closer than 12-15 minutes, which, therefore, indicates the demarcation line between the spheres of motor-buses and trolley-buses.

(3) Replacement of rubber-to-road bearing by metal-to-metal. This is justified when the average service headway is (or will be) closer than 6-8 minutes, which therefore indicates the demarcation line between the spheres of trolleybuses and trams. A sub-division must be made here, however, between municipal undertakings and those privately-owned; the latter are at a disadvantage with purely street tramways, because the obligatory maintenance of the road surface surrounding the track yields no benefit to the private operator, but is of great value to the community. Sleeper-track tramways show an obvious advantage in this respect.

Initial vehicle costs are similar for all three types of vehicle, and amounted to about £40 per seat in the years immediately preceding the war. Large-scale production, as in the case of motor-buses, may reduce this figure slightly. Other characteristics influencing the choice of vehicle are listed at the end of the book, in the "Summary of the General Advantages of Tramways." War-time scarcities of liquid fuel and rubber are ignored here, although they obviously favour tramways beyond the normal spheres of operation quoted above.

The average overall headway of trams on the former London County Council system was under 2 minutes, and the cost of operating them has been estimated by a well-known traffic expert to have been quite £500,000 per annum *less* to the community than by using trolley-buses. Some of the outer London systems however, such as those in the districts of Erith and Dartford, were much more lightly loaded. A recognised competent authority has also estimated that the cost of motor-bus operation in many central London thoroughfares exceeds that of an equivalent overhead-wire tramway service by over £20,000 per mile of route annually. It is clear that the London County Council's desire to operate further extensions of tramways in preference to the company-owned omnibus services then in existence, had it been fulfilled, would have greatly reduced the cost of London's transport to its citizens. In addition, the entire undertaking would probably have reached by now the same praiseworthy debt-free condition as that of Glasgow.

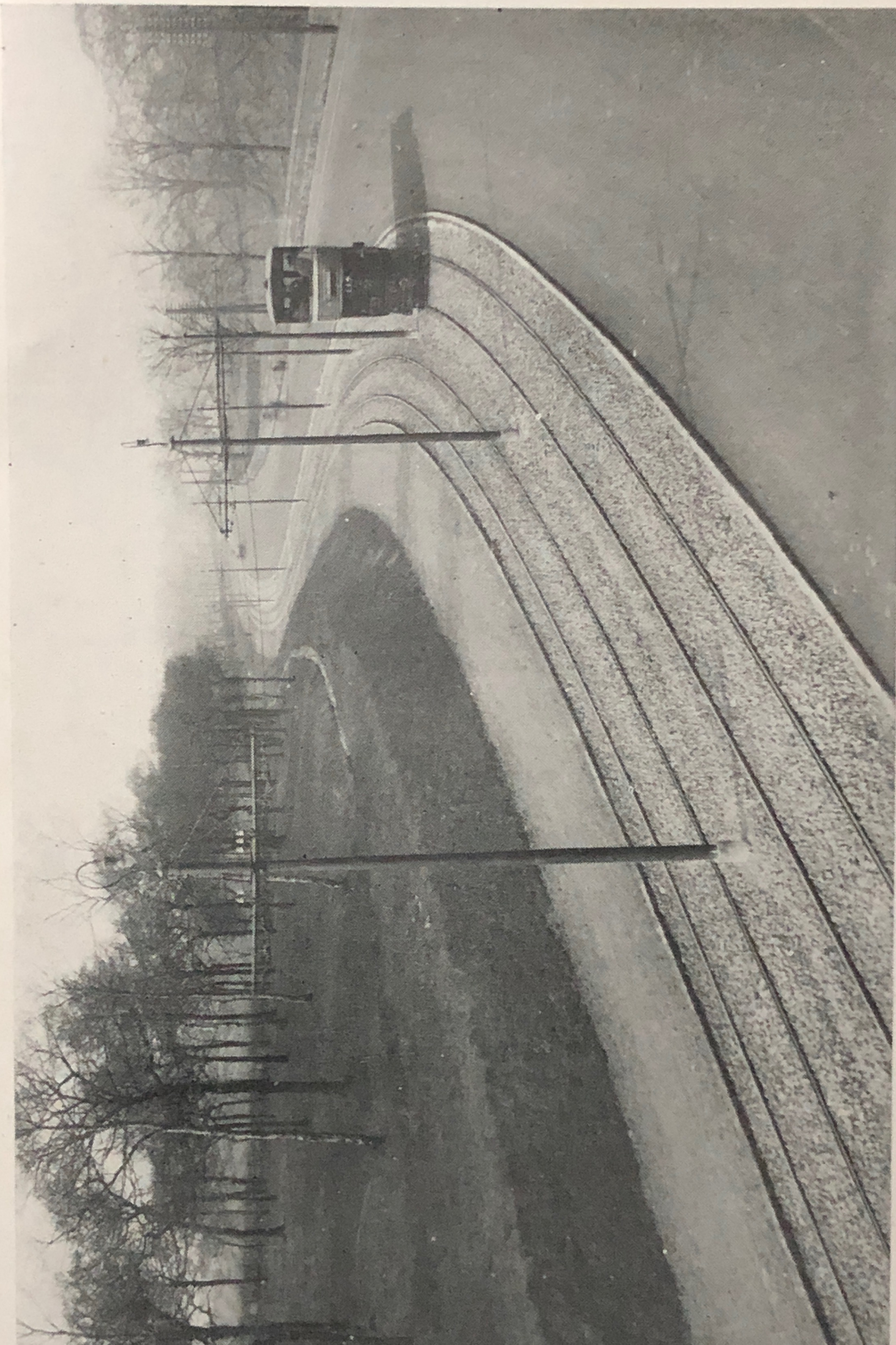
For their wear and tear of public highways, buses pay tax to the Road Fund. The fact that this fund was easily raided to help balance the Budget and cover extravagances in other directions may explain why Governments of the lazy-minded pre-war period appeared to favour buses at the expense of tramways. Tramways carry their load on the steel track they themselves provide and maintain; they also unfairly have to maintain the roadway between the rails and for 18 inches on either side (although this is used by motor vehicles and not by the trams), and have to pay local rates on both!

In spite of these handicaps, however, trams prove cheaper than buses for busy routes, as described in the foregoing comparison of economic spheres, which was based on vehicles in present-day use of approximately equal capacity (60-75 passenger). Greater capacity will require greater length and probably better entry and exit facilities, for which trams are more suitable than buses, by reason of their construction and operational characteristics.

So far as Great Britain is concerned, tramways promote *national* interests by their usage of home-produced electricity and steel, and *local* interests by their contributions towards local road-maintenance and rates, besides their operation at low fare-levels, which releases a larger proportion of the local income for expenditure in other directions, to the great benefit of shops, building societies, cinemas, etc. Of all forms of transport, the tramway is the most truly co-operative in the redistribution of its revenue, and with up-to-date practice can be one of the finest long-term investments an urban community can make.

Abroad, tramway operational spheres differ in extent, due to varying national economic conditions. Thus Switzerland favours trams where the average headway is 10 minutes or closer; indeed, similar conditions normally prevail in almost all Continental countries, since they have little in the form of " invisible "

PLATE II.



THE RESERVED TRACK LINKING GLASGOW WITH THE FORMERLY SEPARATE AIRDRIE AND COATBRIDGE SYSTEM. (More modern cars than that shown, including the "Coronation" type, are now used on this line.) *Photo. courtesy Glasgow Corpn. Transport Dept.*

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[*Photo: Lambson, Northfield.*

Reserved Track High-speed Tramways in two Continents—Left the four-track layout of the Pasadena route of Pacific Electric Railway, Calif., U.S.A.; right, the Bristol Road sleeper track of Birmingham Corporation Tramways, England.

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exports such as shipping, with which to balance import expenditure, and must therefore rely more on domestic resources for fuel, etc. On the other hand, America has (in peace-time) abundant cheap petrol, yet continues to favour trams for traffic reasons. These are bound up with the second cardinal factor, that of route disposition. In all countries, local politics are sometimes a deciding factor.

(B) ROUTE DISPOSITION.

From the standpoint of public transport operation, route disposition depends largely on the width of roads traversed by the service, since this determines whether rail-guided or steerable vehicles will yield the best results having regard to the nature and volume of the accompanying general traffic.

The mutual interferences between various forms of public and private transport sharing common urban highways, and the degrees of congestion resulting therefrom, constitute an exceedingly complex subject demanding very careful study. An impartial and detailed analysis is contained in the standard treatise "Street Traffic Flow," by Mr. Henry Watson (Publishers: Chapman & Hall, Ltd.). In view of the fact that at least two-thirds of Britain's population are frequent users of urban transport, and are directly affected by its problems while possessing only an imperfect superficial knowledge of them, such a book properly merits a place in every intelligent household, alongside the various encyclopedias, dictionaries, atlases and other recognised works of reference commonly found therein.

The following conclusions, however, summarise the results of considerable investigations conducted in many cities at home and abroad.

(1) Generally, the minimum road width (from kerb to kerb) for satisfactory operation of street tramways is 32 feet, which represents four traffic lanes 8 feet wide. On narrower thoroughfares, kerbside vehicle parking is not possible unless the tramway is a single track; this implies delay at passing loops, and is only justified in exceptional cases. At occasional short bottlenecks, such as that in the Croydon main street, a double track tramway with a local restriction on parking is preferable to a single track.

(2) On a 32-ft. road, the *nature* of its traffic determines whether buses or trams will be least congestive. The former may be preferable where slow, heavy vehicles predominate, but the latter if the general traffic is lighter and faster. The worst congestion occurs when buses and trams operate together on roads where considerable parking of private vehicles takes place.

(3) Any large short-stage public vehicle, bus or tram, will cause some degree of delay to traffic following. Buses straddle two traffic lanes when overtaking, and when swerving towards or away from the kerb at stops, where, incidentally, they neutra-

lise parking-space. Trams may delay other traffic at stops through passengers alighting, but are usually less congestive than buses when moving, since they follow a fixed path easily visible to other road-users, and cannot "cut-in."

(4) As road width increases above 32 feet, the balance gradually moves in favour of tramways, insofar as mutual traffic interference is gradually eliminated, and consequent upon the provision of loading islands, which now becomes possible. Where road width is not sufficient to allow for two parallel islands flanking the tram tracks, it may be possible to use central islands in line, each ending with a straight stairway leading down to opposite sides of a common pedestrian subway.

(5) On a six-lane road (*i.e.*, 48 feet wide excluding islands) fairly dense traffic can move comfortably, and no mutual interference with trams need take place. Above this width, adequate loading islands are easily provided, with or without pedestrian subways, and benefit traffic generally by canalising or marshalling pedestrians crossing the road. Note that since an average of 50 per cent. of people boarding or alighting from public vehicles come from or proceed to the far side of the road, the total cross-movement is the same whether buses or trams are used; with the former, half the passenger cross the full width of the road, while with the latter, all the passengers cross half the road.

(6) The wider the road, the faster the traffic tends to move, the greater is the need for segregation, and the more dangerous become buses in swerving out from kerb to crown and back again. On the other hand, trams and motor traffic are clear of one another, and it then becomes possible to dispense with the tramway paving, and so form a track-reservation between dual carriageways. Trackwork is thereby cheaper both in first cost and in maintenance, not being subjected to wear-and-tear by lorries, vans, buses, automobiles, etc., *and the trams can then move freely at the very high speeds of which they are capable.* The greater the proportion of travellers carried by them, the more room available for the remainder on the carriageways.

III. The Influence of Replanning.

It is now generally realised that our main roads, originally intended for horse-traction only, are utterly inadequate for unrestricted fast mechanically propelled vehicles; what is not so well understood is that the same essential widening of them, for the benefit of motor traffic, is equally valuable in providing ideal conditions for the operation of tramways to the advantage of all other road users, besides the public as passengers, and that the resulting rail transport service will, given modern equipment, be on balance markedly superior to anything possible with motor- or trolley-buses, or even automobiles in some cases.

At the beginning of the century, widespread enthusiasm for electric tramways led to many systems, both British and Ameri-

can, being instituted in districts where there was not sufficient traffic to make them economically successful; or at any rate, not after motor vehicles had developed to the degree of practical usefulness. In many instances, early substantial earnings were dissipated in optimistically high dividends, or, in the case of municipal undertakings, drained to help out the local rates, without adequate provision for renewals of rolling-stock and track. So when their initial equipment became worn out, replacement by buses was the only course economically practicable, bearing in mind the light traffic-loads obtaining. One car every two or three hours sufficed on some of the long single-track interurban lines in America. Outlying villages and farmsteads so served found the cheap mass-produced automobile a better proposition.

However, a number of British towns operated well-loaded tramway systems which were consistently successful and profitable, but which were abandoned nevertheless, because narrow or otherwise unsuitable streets prevented modernisation of track layouts and operation of up-to-date tramcars offering standards of comfort as good as or better than present-day buses. The substitute services provided on main routes by the latter type of vehicle may appear better superficially, by comparison with the obsolete tramcars so replaced, but must prove considerably more expensive in the long run. Reconstruction of such towns will again enable them to benefit by tramway transport, this time under ideal conditions, and officials in charge of the local transport undertakings should fully appreciate the new possibilities opened up, with the reappearance of a sphere for tramway operation. Failure to do so may lead to grave errors of policy, resulting in the retention of unnecessarily " flexible " services, which are neither cheap, safe, nor efficient, and which will be rendered obsolete by their fundamental limitations.

" Flexibility " of road services finds too many advocates who fail to appreciate the difference between the various senses in which the term is applicable. It may be interpreted as follows:

(1) In the sense of *steerability* in traffic. As already explained, this is no unmixed blessing, and in the case of large public transport vehicles on wide roads is better replaced by a mechanically-compelled segregation.

(2) In the sense of being able to vary the intensity of service over any given route or portion thereof. This is a truer definition of *flexibility*, and is evident less with rubber-tyred vehicles than the trams, since the former require turning-circles, loops or triangles, whereas the latter can reverse at any convenient crossover without hindering other traffic, and possess a useful margin of elasticity in their overload capacity.

(3) In the sense of being able to transfer some or all the vehicles to a different route or area in any system. This is better described as *mobility*, and can hardly apply to trolley-

buses more than trams. The motor-bus is mobile, but the attribute is only necessary for a minor proportion of the passenger vehicles operated by any large municipality. For its main services, regularity and low fares are more important, and where these are provided by modern tramways, their profits often permit the operation of unprofitable but extremely valuable bus routes to serve outlying districts, as at Glasgow, Sunderland, etc.

Flexibility, in its broader loose sense, is only the first stage in the development of any transport service. Next, economy demands a measure of fixed or built-in equipment co-related to the degree of permanence expected of the habitations and amenities served. The stability implicit with planned communities will prove an economic feature only second in value to the intensity of load. Regarding this latter feature, it is worth noting that even the most vigorous and widespread reconstruction of any city is unlikely to displace more than 20 per cent. of its population. (For the county of London, this would entail the dispersal of approximately one million people.) The majority remaining will still provide on main routes load densities well within the sphere of tramway operation.

IV. Future Technical Developments in Tramways.

When considering the future development of tramways in Britain, two important characteristics must be kept in mind. Firstly, that almost all existing systems are urban and municipally-owned; and secondly that the tramcar has a longer life than any alternative vehicle, and therefore requires the exercising of considerable foresight on the part of its designers and operators, with a careful appraisal of future factors to include social as well as technical trends.

Tramway undertakings should make full use of the special financial possibilities inherent with municipal ownership, while at the same time exploiting to the uttermost the various advantages peculiar to the use of rails. In the latter field, great progress has been made by American systems during the past few years, so it well worth examining some of their general features in conjunction with our own.

Fare Policy. In the U.S.A., almost all public road-vehicles, whether trams, trolley-buses or motor-buses, are one-man operated; passengers pay the driver on entering at the front, and leave by a central or rear exit-door. Two-man vehicles are found only on the heaviest-loaded city routes. Fare payment is simplified by charging at a single flat rate, usually 7 cents (approximately 3d.), for any distance. Almost all systems are company-owned.

One-man "Pay-as-you-enter" operation certainly reduces costs, but its present application in Britain is limited by the

prevailing sliding-scale fare tariffs and the extensive use of double-deck vehicles. Cardiff has successfully introduced a universal penny fare, paid into a box on the rear platform when entering, under the conductor's supervision. A more revolutionary system peculiarly suited to municipal ownership has even been advocated in some quarters; viz.: one-man operation with no direct fare-payments, the undertaking being sustained by the local rates, which would be suitably increased to cover the cost. Obviously, not every town could adopt such a scheme; for example, a seaside town might compromise by issuing period-passes to residents, while visitors could pay on entering the trams, which might employ seasonal auxiliary conductors where necessary. On the other hand, a compact inland city with all its districts well served, might usefully adopt the idea; the city's proportion of non-residents being small enough to have no appreciable adverse effect.

Advocates of the "pay through your rates" scheme claim several advantages, of which the most important are a 20-25 per cent. reduction in operating costs and extreme simplification for the passenger. Such a radical change would, however, require to be approached very carefully, and introduced by gradual stages concurrent with the growth of civic responsibility among local citizens. Since the type of vehicle used would require simplicity of control and a good overload capacity, the tramcar appears to be well suited to the purpose.

Route Disposition. The tram's ability to reverse at a terminal stub without requiring to turn has led some traffic experts to advocate tram-routes terminating on the fringe of central areas, while bus services continue across, through the usually narrower city streets. These conditions obtain in London and Birmingham, but there are certain objections. Where motor-buses are used in confined streets, their fumes are detrimental to health, while their noise may be intolerable.

Alternatively, heavy services of trolley-buses under similar conditions may result in a correspondingly heavy death-roll among pedestrians. The remedy is to turn back the buses instead, by loops or a ring-road, and to continue the tram-routes or a suitable proportion of them across the city area through shallow subways. This will not only overcome the objections mentioned, but by removing all large public-service vehicles from the central streets, will provide much more room for the movement and parking of automobiles, commercial vehicles and goods delivery vans, the last-named being essential to the life of any city. Moreover, the trams, freed from all obstructions, can maintain much higher speeds with 100 per cent regularity. Devoid of elaborate stations with pre-booking facilities, and complicated block signalling, such subways will be cheaper to construct than ordinary underground railways, while posessing the same degree of permanence, exemplified by London's original Metropolitan Railway tunnels, which are still in heavy

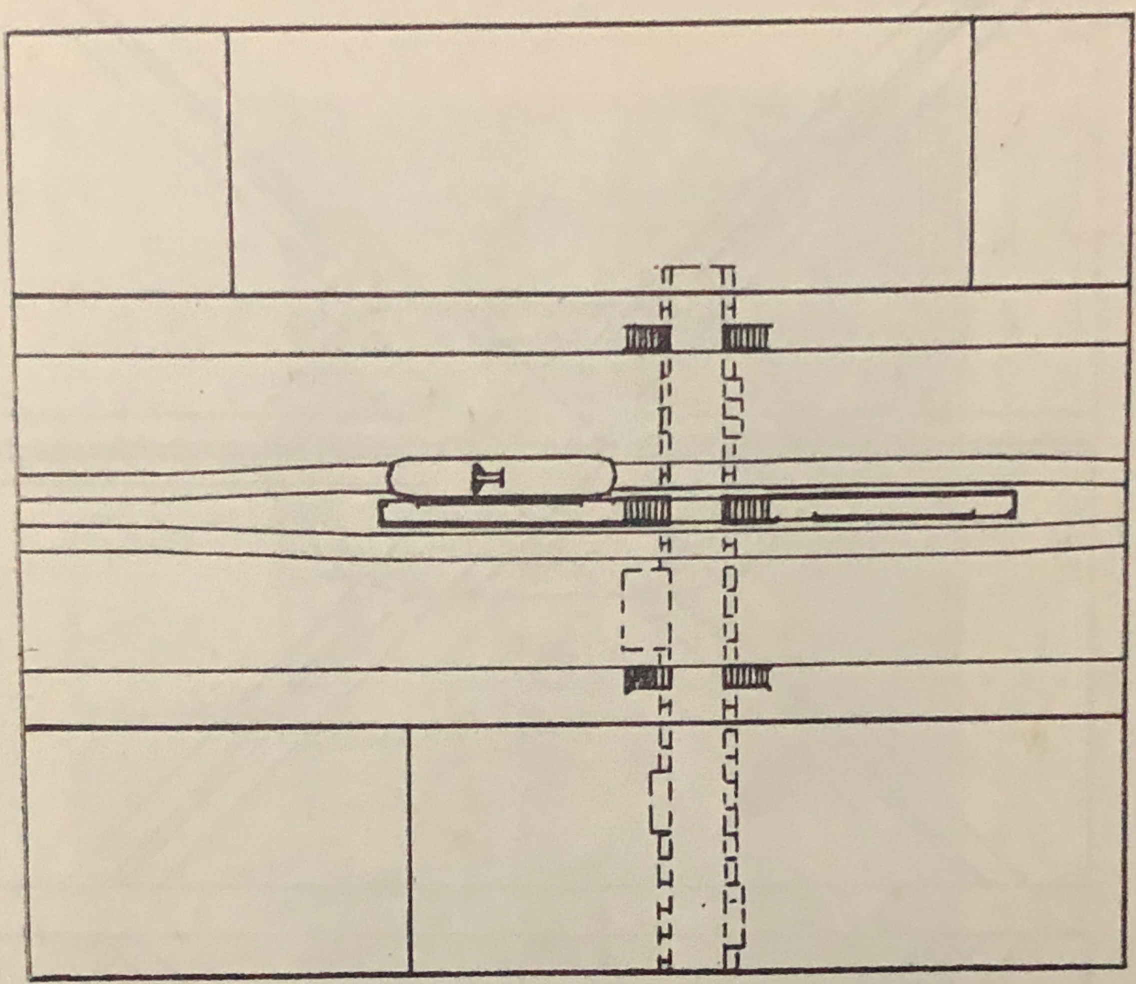
daily use after 80 years continuous service, with good prospects of lasting as long again!

Any large-scale reconstruction of central streets, however, would permit of widening sufficiently to favour surface trams, with adequate provision of loading islands; such routes are more accessible and less costly than subways, although numerous busy side-streets and traffic intersections might make the latter more desirable. Simple surface crossings without left or right turns present no difficulty, but where such turning is involved, the gyratory or roundabout system can be quite successfully applied to tramways. In the case of heavily-loaded multiple intersections, however, short subways with underground junctions or "basement" roundabouts offer great possibilities, including quieter and more easily maintained "open" point-work for the trams, and reduced traffic density for surface vehicles where it is most needed. Even the most complicated intersection problems, such as South London's "Elephant and Castle" can be solved in this manner.

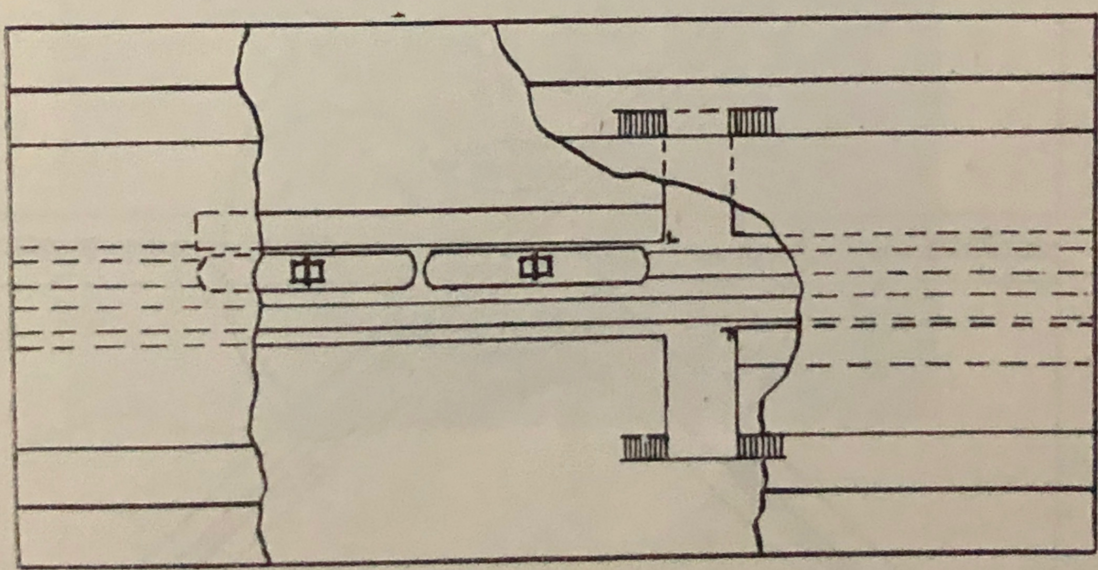
The general principles are (1) to keep separate any heavily-loaded opposing streams of vehicles, and (2) to facilitate their continuous flow. In the past, there have been many instances of such large-scale reconstruction schemes involving the diversion of water mains, sewers, etc., in which advantage has been taken to re-lay and modernise these installations for the general good of the public.

Where two such junctions are situated close together, the short linking route would also be preferable as a subway. There seems to be no reason why pedestrian subways should not make level crossings with tram subways at stops, provided that the loading platforms are disposed one on each side of the crossing, so that the trams stop naturally before traversing it. Colour-light signals could render such sub-surface crossings 100 per cent. safe, with little delay for the pedestrians and none for the trams if such signals were synchronised with the setting-down and picking-up of the tramway passengers. Pedestrian subways generally can be made far more attractive than is usually the case at present, by the installation of illuminated showcases hired out to local shops, and the provision of booths for tobacconists, newsagents, etc. Another useful amenity is a direct entrance from the subway into the basement of any public building or departmental store, such as that giving access to Messrs. Swan & Edgar's from the circulating hall under Piccadilly Circus. Installation of escalators to improve access has recently been suggested by Mr. P. J. Noel-Baker, Joint Parliamentary Secretary to the Ministry of War Transport, as a means of further popularising pedestrian subways. There is little doubt that they will be much more extensively used in the future,as will also their tramway counterparts.

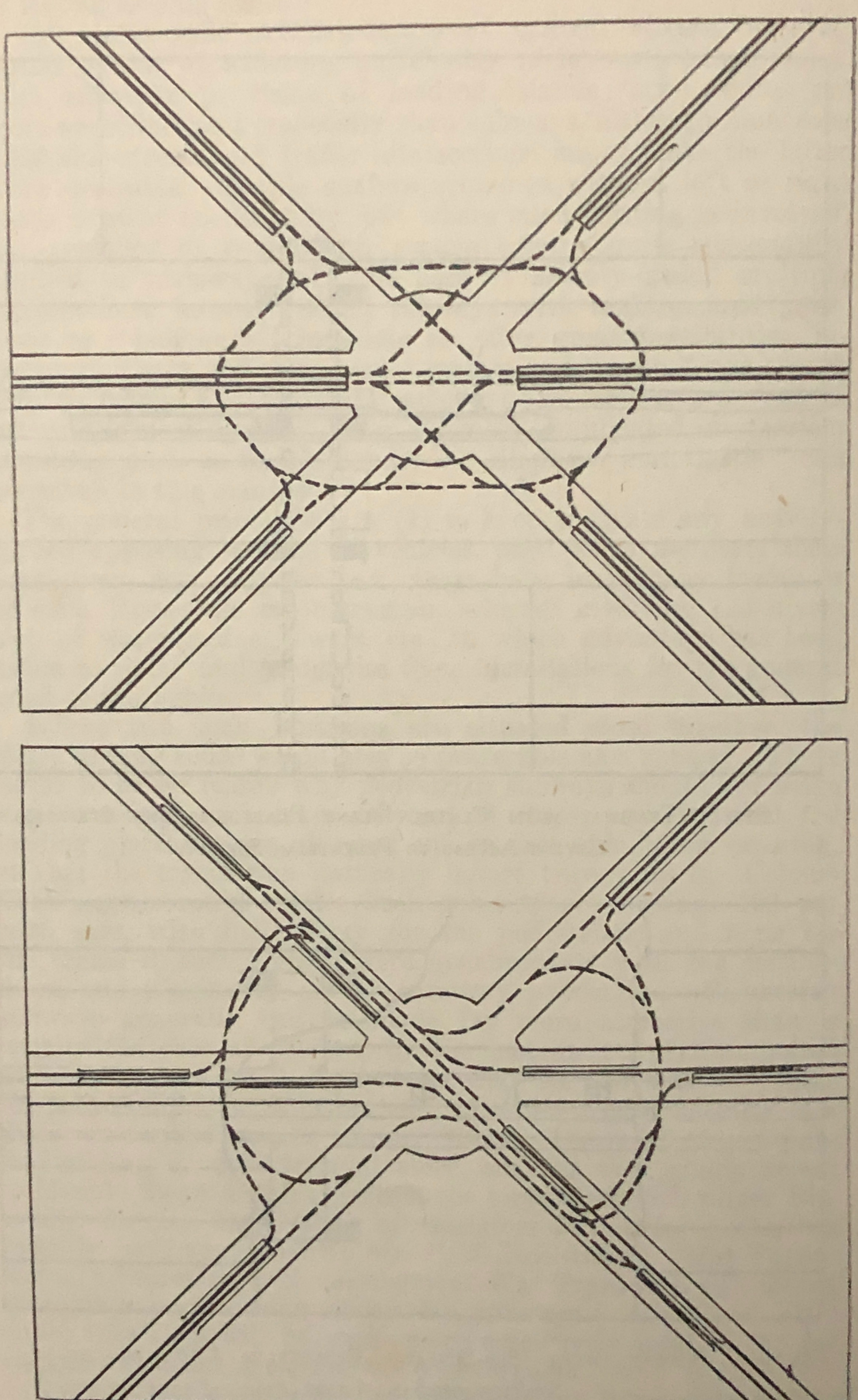
A noted traffic authority has suggested an interesting alternative to subway construction, by the provision of tramway-track reservations in shallow open cuttings *behind* the buildings front-



Street Tramway with Centre Island Platforms and Staircases Giving Access to Pedestrian Subway.



Tramway Subway with Sub-Surface Pedestrian Crossing at Station on Same Level.



Sub-surface Tramway Junctions at Six-road Intersections.

PLATE IV.

A VIEW OF "CLOVER-LEAF" TRAFFIC INTERSECTION AT SLUSSEN, STOCKHOLM (SWEDEN).
Note the use of tramway terminal loops and loading islands.

[*Photo: Harald Olsen, Stockholm.*

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PLATE V.

Two Advanced Scottish Designs.—Above, "Coronation" bogie car at Glasgow, described as the finest in the world. Below, modern Aberdeen single-truck car.

Blocks courtesy "Modern Transport."

ing main central streets. Access would be easily provided by short flights of steps from other streets at right-angles which would bridge the tramway. Such a method would make economical use of the space behind buildings, necessary for natural lighting and air shafts.

Where a tram-subway can debouch directly on to reserved tracks, making the route a reservation throughout, ideal conditions will exist for the provision of a local passenger transport service faster, safer, more comfortable and more regular than anything possible with buses, while at the same time offering cheapness and accessibility to a much greater degree than ordinary railways. And the savings possible over a long-term period such as twenty or thirty years, will help in large measure to pay the general reconstruction costs, to the lasting benefit of all classes of road-users.

Tramcar Design. Always popular in Britain, double-deckers offer large seating capacity with compactness and low weight per seat, together with simple segregation of smokers. True, the upper deck accentuates vehicle oscillations, but it is usually quieter, and presents an elevated viewpoint having a strong psychological appeal to a nation of sailors, explorers and equestrians. The double-decker has yet to be appreciated in congested Continental towns; even the United States might find modern designs of this well-proven type useful in certain localities. In urban districts it is rarely slower than the single-decker, and then only for local reasons. (Certain modern American diesel locomotives having approximately the same 15 ft. height as British double-deck vehicles, and the same relative centre of gravity, frequently achieve 110 m.p.h. on straight track and over 90 m.p.h. on suitably-banked curves!) On the other hand, where subways of any length are involved, constructional costs would obviously favour single-deckers. So also would rapidity of loading and unloading, although this only applies to common present-day practice. Some authorities consider the single-deck vehicle more desirable from the point of view of road safety, however, since its conductor can more easily be present on the platform at stopping places, and better superintend passengers boarding or alighting.

Since the tram is generally more capacious than the six-wheel bus, and the former's reversibility entails two staircases, there is a strong case for using both staircases together. Most tramway operators agree on this point, but are often hampered by local bye-laws and prejudices favouring the traditional entry and exit position, at the rear of vehicles because years ago the horses were in front.

Modern central-entrance-and-exit cars in use at Blackpool, Sunderland and Aberdeen are distinctly quicker in loading than the more orthodox types. Very good results have been obtained in Newcastle with rear-entrance front-exit cars; this arrangement also obtains on the London "Felthams," effecting a 20 per cent. average reduction in stopping-time. Had these cars

not been mixed in with older cars, but used instead exclusively on suitable routes, habitual passengers would have become fully accustomed to alighting from the front end at all times, and still better results would have been achieved. Even now, the "Feltham" tram is still the best public vehicle on the London streets, from the standpoints of high load capacity, rapidity of loading, all-weather reliability, and steadiness in running.

In the Metropolis, at any rate, separate exits are badly needed elsewhere; future speeding-up may make them highly desirable, and well worth embodying on new cars, even if not so used in the immediate future. Two or three years ago the Light Railway Transport League sponsored a design for an "Ideal" tram which deserves consideration in this respect, since it caters for:

(1) Loading and unloading on either side through power-operated doors, thus permitting the use of either central or flanking islands at stops. This feature would also prove of great value should the rule of the road be altered, to "keep to the right;" a change advocated in some quarters, although there would be many difficulties to overcome, not the least being heavy capital expenditure with no increase in revenue.

(2) Using rear-entrance with front-exit, or front-entrance with rear-exit (permitting one-man P.A.Y.E. operation), or both-ends exit and entrance, railway-fashion. Again, orthodox rear entrance and exit, or front entrance and exit, as used on many single-decker buses, can be practised until local circumstances change; meanwhile the unusued loading-platform will always serve for rush-hour standees, or as extra space for luggage and folding prams. Accommodation for the latter seldom exists on buses.

Another feature of the L.R.T.L. car is that whereas window seats are the most popular with passengers, but gangway seats are the most accessible, 67 per cent. in each category are provided, against 48 per cent. and 52 per cent. respectively in the best present-day trams and buses.

The proposed design incorporates many P.C.C. features, especially with regard to its trucks. Here, the principal innovations are:—

(1) Motors mounted with their armature axes fore-and-aft, each transmitting to a main axle at right angles through hypoid gears. This eliminates spur gearing, probably the biggest single factor in tramcar noise, and reduces unsprung weight.

(2) Main frames are disposed between the wheels (instead of outside them), and are steel tube, with welded-on lugs for the attachment of motors and equipment. This makes for lightness and compactness.

(3) The bolster carries a deep conical socket, in which seats an equivalent long tapered king-pin rigidly attached by a strong "spider" to the car body. This eliminates side rubbing-plates, but they might nevertheless still be necessary for double-deck cars.

(4) Springing between axles and frames is effected by rub-

ber blocks in compression, thereby reducing minor noise and vibration. This feature has been successfully embodied in a recent Maley & Taunton design produced in this country However, other modern British trucks, incorporating the more orthodox steel laminated springs, underslinging the axles and eliminating hornways, have given very good results.

(5) The wheels incorporate a cushion of rubber between steel tyre and hub. This most valuable feature not only ensures smooth quiet running, but also helps to effect marked reductions in tyre wear, although the chief factor here is the greater use of dynamic braking instead of the more orthodox blocks acting on the tyres. In some cases, a life of nearly 200,000 miles has been claimed. Track life has also greatly increased, particularly at points.

Many P.C.C. cars are single-ended, operators considering that the costs of installing terminal loops are more than offset by the reductions in control equipment and doors made possible, together with the increased seating capacity, the seats also being of a slightly lighter non-reversible type, with added comfort. On the other hand, the tramcar's ability to reverse is usually regarded as one of its most valuable traffic features, especially in Britain. Excepting a few special cases, notably Rotherham, the field for single-enders in this country seems to be confined to inter-urban or railway branch-line uses, where odd land for loops might be more readily available. On such routes, extremely high speeds may be possible, in which case the unidirectional single-ender lends itself better to accurate streamlining. However, double-ended P.C.C. cars are also supplied, such as those recently put into service by the Pacific-Electric tramways' undertaking. These are equipped for multiple-unit operation, and also for automatic brake-control in conjunction with track-stops, as used on London's underground railways.

Tramcar Construction. Aeronautical engineering has sponsored developments in light-weight materials which will prove of ever-increasing use to ground transport. For all vehicles, reduction in weight helps acceleration, shows economies in power consumption, and reduces tyre wear. Furthermore, the path trodden by the tyres is also subject to less wear, though if it consists of road surfaces, the vehicle operator benefits only in accordance with taxation levels arbitrarily fixed by the Government. If the vehicle runs on rails, however, the operating concern benefits directly by the reduction in wear of its own property. Many of the lighter materials, light alloys especially, cost rather more than the orthodox steels and timbers common hitherto; hence their employment tends to be a better economic proposition for the rail vehicle with its longer life over which to spread repayments, rather than the comparatively short-life road-vehicle. This is born out by experience in the United States, where the recently-developed high-speed diesel-driven streamline trains embody light-alloy construction to a far greater extent than any modern buses.

For panel work on transport vehicles the 1914-1918 war brought forward the merits of aluminium sheeting, which in addition to its light weight, is weldable and easily malleable, making it ideal for surfaces possessing double curvature, such as domed roof-ends and other streamlined shaping. Duralumin, though stronger, was not much in evidence, since in sheet form it usually requires multitudinous rivets for assembly, while in bar or billet, where machining is involved, it was generally considered less durable than steel, particularly for rotating or moving parts. The last few years, however, have seen great progress made in the technique of forging light alloys, and in this form they can now often take the place of heavy steel members. Extruded sections have also developed considerably; long pieces serving as longitudinal support or girder members, shorter pieces as transverse stiffeners and intercostals, and short off-cuts being ingeniously employed for joint-fittings which previously called for extensive machining from solid, or built-up welding. Oslo and other cities have lately put into service trams of duralumin " monocoque " construction, similar to that used in aircraft practice.

Resin-bonded plywoods and sheet-plastics show great promise, and may prove superior to metal for noise-reduction. The latter class of material is widely used for pilots' seats in aircraft nowadays, and seems to offer similar scope for light-weight seating in transport vehicles. Worthy of mention are the ultra-light sheet plastics such as " Pytram," used for ducts in cockpit air-heating systems; these seem to foreshadow air-conditioning and mechanical ventilation for rail-vehicles in this country, as in America.

An interesting feature of certain air-liners is the use of kapok or asbestos wool loosely sandwiched between inner and outer metal shells forming the passenger cabin, to insulate against noise and temperature changes. Flexible transparent materials such as " Perspex " may also find a much wider usage; one can visualise vehicle roofs so constructed for maximum daylight illumination. Without doubt the high-speed tram of the future will offer great scope for modern engineering technique.

Tramcar Equipment. Many features of the P.C.C. car will probably come into general use, particularly the smooth notchless rheostatic control, and the co-ordinated dynamic, wheel, and track brakes. Power-operated doors have reached perfection with newer electric and pneumatic mechanisms. One possible development for one-man double-deckers is a treadle-operated passenger counter or indicator, adding for every person boarding and subtracting for every person alighting, in order to show the driver how many people he has on board.

Blackpool's enterprising transport manager, Mr. Walter Luff, recently suggested radio-telephone equipment for trams, to enable their crews to keep in touch with central traffic controls, in order to extend or curtail vehicle workings according to current requirements, which are subject to sudden variations

through weather changes, etc. Another application of electronics will be the small standardised television receiver, properly accommodated in the driver's cab, enabling him to see through fog whether the track is clear, thereby enhancing the rail-vehicle's inherent superiority in this respect, by permitting operation at full speed, or nearly so. This idea is by no means far-fetched; any of half-a-dozen leading radio firms could manufacture such apparatus immediately, were this not prohibited by military necessity. It is even possible to embody stopping devices which operate automatically when a given proximity to the car in front is reached. For central subways, however, colour-light signals in conjunction with track-disposed trip-cocks, as perfected by London Transport on its railways, may be preferable; mention has already been made of similar equipment on P.C.C.-served Pacific-Electric reserved-track tramways.

Tramcar Performance. The inherent advantages of straight-line motion and low rolling resistance, with electrical propulsion on all axles and co-ordinated multi-operation brakes, plus modern engineering design, make the tramcar *potentially* the fastest of all public-service ground-transport vehicles. The following figures are based partly on actual running with P.C.C. cars on clear roads or reserved tracks, and partly on high-speed inter-urban practice. The former make stops of about 8 to 10 seconds average duration, on city routes; in the latter case, stops vary from a few seconds up to a minute or so.

(A) City and inner-suburban services. Top speeds: 40-50 m.p.h.

No. of stops per mile:	11	10	9	8	7	6	5	4	3	2
Average speed incl. stops: (m.p.h.)	12	12	13	14	15	16	18	20	23	27

(B) Outer-suburban, nearby airport, and satellite-town services.
(Top speeds: 80 90 m.p.h.)

No. of miles per stop:	1	2	3	4	5
Avg. speed incl. stops. (m.p.h.)	40	50	60	70	75

(C) Inter-urban (arterial-road reservation, or railway) and distant-airport services. (Top speeds: 110-130 m.p.h.)

No. of miles per stop:	3	5	10	20	40	60
Approx. average speed incl. stops (m.p.h.):	65	80	90	95	100	100

P.C.C. car acceleration of 4 m.p.h. per sec. is based on the comfort of standing passengers; much higher rates are possible when people can seat themselves first, the slight extra stopping time being more than compensated for on ultra-high-speed services as in categories (B) and (C). The maximum safe top speed for P.C.C. city-service cars is considered to be 50 m.p.h., but over 70 m.p.h. has been attained on street tracks, experimentally.

Regular speeds over 50 m.p.h. would necessitate deeper railway type wheel flanges, and would therefore require "open"

track throughout, implying virtually a 100 per cent. reservation.

Tramway Speed Regulations. These mostly date from the period when it was considered essential to precede an automobile by a man carrying a red flag. The following are suggested for adoption by the Ministry of Transport as being more in keeping with the recent great advances made in tramcar design and equipment:—

Standard Gauge (4 ft. 8½ in. or 4 ft. 7¾ in.).

Street tracks. Double-deckers 30 m.p.h., Single-deckers 30 m.p.h.

Reservations. Double-deckers 40 m.p.h. Single-deckers 50 m.p.h.

Narrow Gauge (4 ft. 0 in. or 3 ft. 6 in.).

Street tracks. Double-deckers 25 m.p.h., Single-deckers 30 m.p.h.

Reservations. Double-deckers 35 m.p.h., Single-deckers 45 m.p.h.

Local restrictions on curves and at junctions would be imposed as necessary.

The foregoing assume the cars to have wheels with shallow flanges as used on ordinary grooved tramway-rails. Where deep flanges are used, implying open track throughout, conditions are more comparable with railway practice. Here in order to permit the development of ultra-high-speed tram services, no general limit should be imposed, but only local limits depending on the types employed and the physical characteristics of the routes they are operated on.

A Field for Private Enterprise. From the economic standpoint, open track is preferable to street track. Ultra-high speed, possible on inter-urban reservations, may shift the balance in favour of the tram, since the required vehicle mileage is obtainable with fewer vehicles, possibly single-enders, reducing the capital outlay well below that necessary for an equivalent number of 30 m.p.h. buses.

Again, crew costs would be much less, particularly by taking advantage of the tramcar's simplicity of control to employ one-man P.A.Y.E. operation. This would probably more than offset the higher costs of power and maintenance. The foregoing considerations may show to advantage in the future, when operators of inter-urban buses (and possibly the railway companies as well), have to provide services capable of competing against private automobiles and aircraft.

V. Airways.

Of all transport vehicles, the aeroplane is the most advanced—and the most advancing. The need for possessing the greatest possible speed margin to counter adverse headwinds, has always influenced development in the direction of ever-greater speeds, but in general the small wing-areas necessary to achieve them

preclude machines from becoming airborne at low speeds. For safe operation they require large unobstructed aerodromes, the costly provision of which limits their number and accessibility. This factor tends to restrict the use of transport aeroplanes to comparatively long journeys, although the continual vigorous development of aeronautical science will gradually decrease the critical distance regarded as the border-line between air and land travel.

Another form of aircraft much in the public eye at present is the helicopter, which can be sustained in the air at low or non-existent forward speeds, by means of an airscrew revolving about a vertical axis. The requirement of motion in two planes at right angles to one another, however, results in a serious loss of mechanical efficiency, which reflects in the low top speed inherent with this type, placing it at the mercy of adverse winds and weather to an extent that will usually nullify any advantage over surface transport it might otherwise possess. Tenacious and energetic research may discover some new principle to effect improvement; no one can deny such a possibility, but the consensus of qualified reliable opinion in aeronautical circles, is that there is little likelihood of helicopters becoming a major factor in short-distance transport for some years to come.

On the other hand, millions of men and women are undergoing first-hand experience of aviation in the Royal Air Force and the aircraft industry. Following on are the adolescents acquiring an aeronautical outlook through the Air Training Corps, and the still younger generation who regard the aeroplane as a normal feature of everyday life.

Beyond all doubt these fresh multitudes will look primarily to the air for inspiration and employment in the post-war world, and will ultimately tend to regard all ground vehicles as short-distance complements to ever-expanding air transport services.

There will also be great developments in at least six other categories, viz.:

(1) Privately-owned light aircraft.
(2) Training and tuition.
(3) Club and other co-operative flying.
(4) Hire-and-fly yourself.
(5) Charter and taxi.
(6) Light freight.

LINKING AIRPORT AND CITY.

A means of really rapid transit between city centres, residential suburbs and local airports is absolutely essential for all these. Many people of modest means will not be able to afford to fly and run a car as well, nor, indeed, will they find much satisfaction in steering along crowded roads after exercising the totally different functions entailed with piloting aircraft, and enjoying the infinitely wider horizons opened up by their use. Such people will look to public transport instead, and when it

is recollected that the road journey from central London out to Croydon plus the road journey from Le Bourget into Paris often took as long as, or even longer than, the actual flying time between the two airports, clearly some specialised or "built-in" form of transport is required for this purpose; the cost of which may prove small by comparison with the total cost of the airport so served. It should also be borne in mind that modern radio devices enable aircraft to take off, fly and land in fog or otherwise bad visibility, hence connecting services between airport and city must be able to operate in similar conditions, under which steered road vehicles may prove useless.

In technical circles, an ever-increasing volume of opinion favours the ultra-high-speed light railway as the answer to this vital problem. For cities of less than, say, 300,000 inhabitants, served by an airport from four to seven miles distant, shuttle operation over a single track with no intermediate stop might suffice. The inner portion of such a route would pass under busy central areas through a shallow cut-and-cover tunnel. The basis for this would be a trough about twelve feet square, cut or scooped out from main streets followed. Modern levelling and preparation of aerodromes shows what can be done by large machines designed for specific jobs, whilst the portable electro-magnetic devices used by our Army engineers for detecting buried land-mines, suggest a means for quickly locating hidden pipes, cables and sewers in the path of excavation. Pre-fabricated concrete units, such as have been used for the rapid construction of air-raid shelters, would serve for lining and covering the tunnel, which would debouch in the suburbs on to a railed-off right-of-way alongside main roads or existing ordinary railways, although for the last few hundred yards to the airport terminal buildings a reversion to sub-surface construction might be desirable in some cases.

Assuming a route six miles long, a start-to-stop average speed of 75 m.p.h. is possible, and a service at 15-minute intervals in both directions could be maintained, using cars capable of being operated either singly or coupled to form a short train, according to traffic requirements. For a peak capacity of 60 passengers per car, a three-car train could discharge 700 passengers per hour at either terminus; a rate high enough to cater for an extremely busy airport. A simple "shuttle" service of this type would not need any form of signalling, nor any loop lines unless a longer run were involved, in which case a single passing loop at about half-way would halve the shortest headway otherwise possible, and permit a brief halt to be made for interchange facilities with local transport routes serving that side of the city. A double-track route, would, of course, possess a much greater capacity, and make possible a division of the airport service to spread over three or four limited-stop routes, preferably on 100 per cent. reservations, fanning out from the city centre on the opposite side. Although it is desirable that the service should make as few intermediate stops as possible

[Photo: W. A. Camwell.

Two Modern Lancashire Streamliners.—Above, Liverpool Corporation car, Below, Darwen Corporation.

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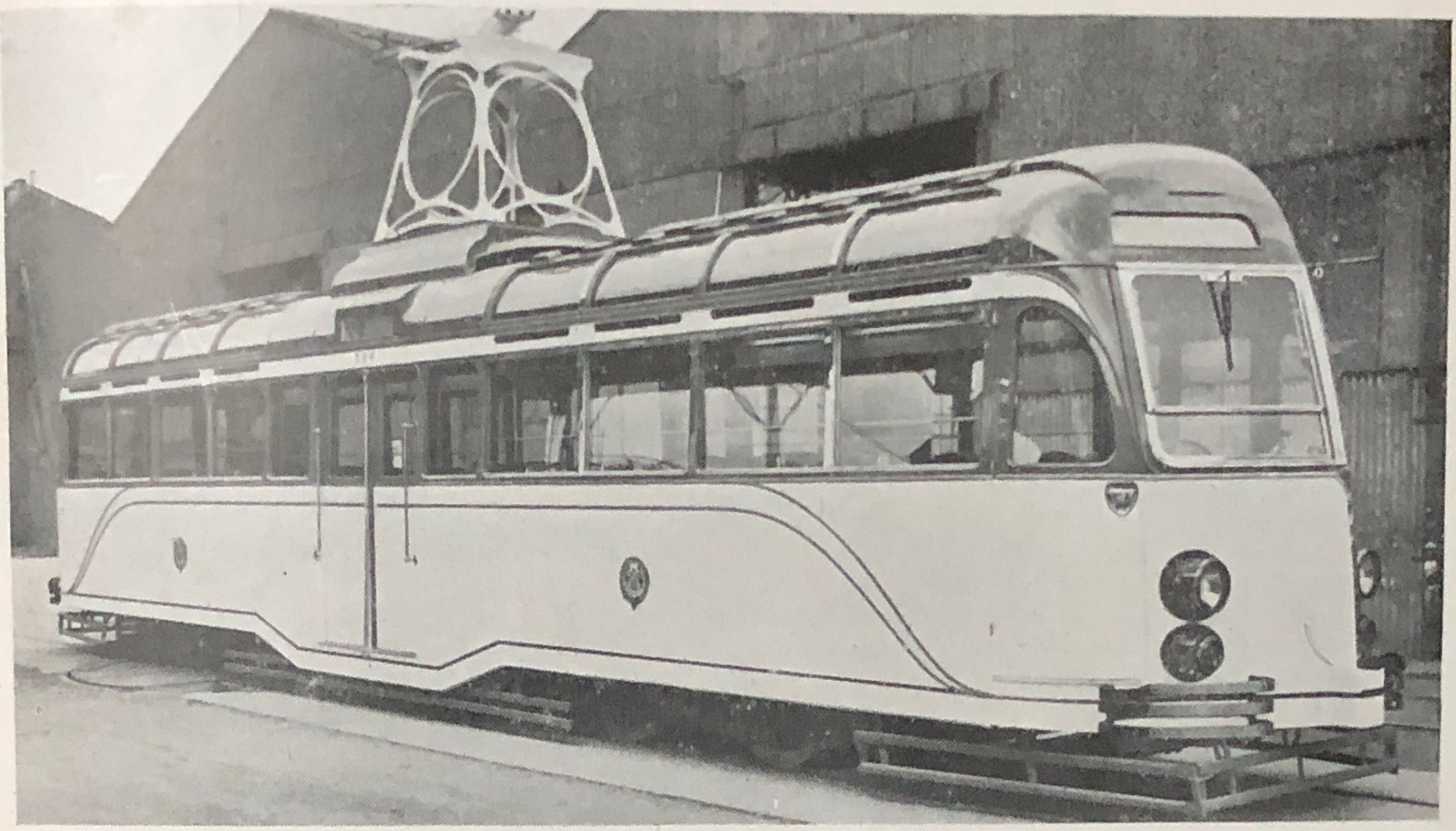
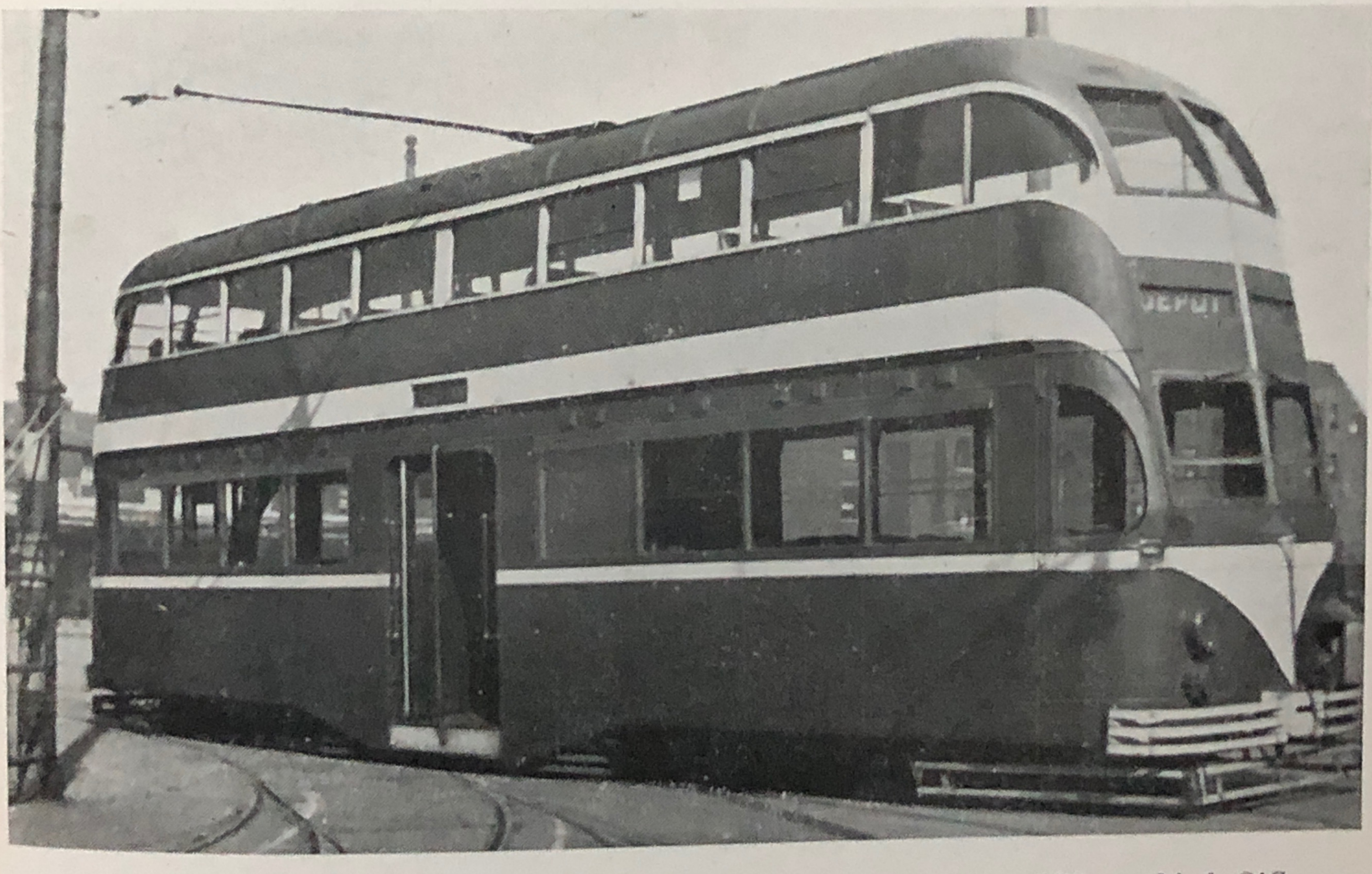
TYPICAL "PRESIDENTS' CONFERENCE COMMITTEE" CAR AS SUPPLIED TO BOSTON ELEVATED RAILWAY, MASS., U.S.A. These cars are the most silent street vehicles yet produced, and have unrivalled comfort, safety and acceleration characteristics.

PLATE VIII.

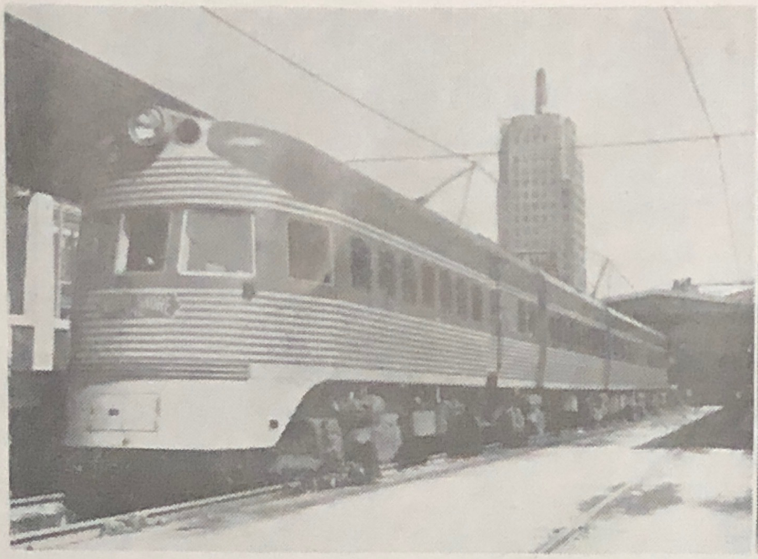


[*Block courtesy "Modern Transport."*

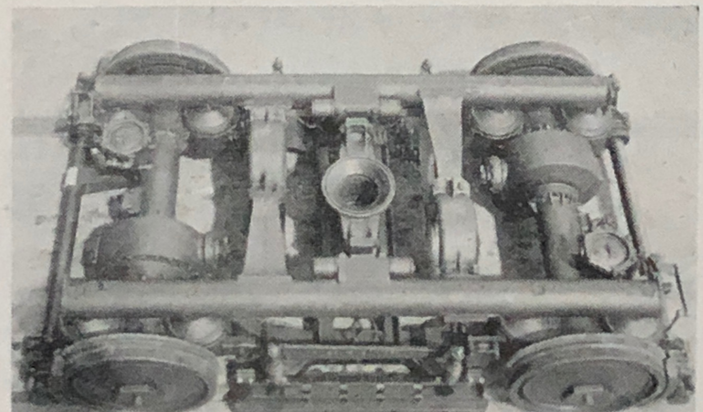


[*Photo: M. J. O'Connor.*

Two Modern Cars of Blackpool Corporation.—Above, single-deck 'Railcoach' as used on the interurban Fleetwood line; below, double-deck car of similar design used on the shorter routes.

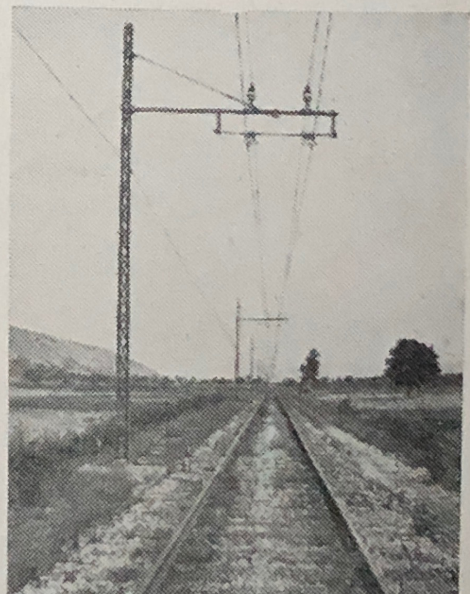


Two Views of the Streamlined "Electroliner" Rolling Stock of the Chicago North Shore and Milwaukee R.R. Using ordinary trolley poles, these cars regularly attain 90 m.p.h. in service.



The Specially Designed Truck of the P.C.C. Car.—Resilient "rubber sandwich" wheels, magnetic brake, and special silencing devices are incorporated.

[*Blocks courtesy "Modern Transport."*



View along Track of Florence-Bologna High-Speed Electric Railway, showing the unobtrusiveness secured, and the small space occupied by high-speed arteries when worked by electric cars on rails.

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nevertheless where any such stops are deemed to be necessary the electric car on its reserved track should always prove faster than any other form of transport making the same number of stops.

To obviate collisions, aircraft arrive and depart from airports in succession rather than simultaneously, and the largest types will carry far fewer passengers than a ship or train. Hence the flow of traffic to be catered for by the rail link, will be continuous and of medium density, plus certain minor peak periods. Moreover, the class of people able to afford air travel will value their time highly and be prepared to pay a little extra for quick ground transit. Hence single " trams " or short units operating at frequent intervals will be much preferable to the usual type of multi-coach train operated on a longer headway.

Standard-gauge electric railway cars have achieved over 130 m.p.h. experimentally, and over 100 m.p.h. in actual service, so it is not too much to expect that the streamlined lightweight railcar or tram specifically designed for high speed over short distances, may become the true complement to the aeroplane, and thus play a useful part in the future development of civil aviation. Conversely, aircraft must exert an ever-increasing influence on other forms of transport, not only by demonstrating the value of speed in reducing present wastages of productive and recreational time, but also by making available the fruits of that most intensive engineering research which has in forty years advanced the aeroplane from a derided dream to world-wide omnipotence.

VI. Railways.

One of the most outstanding lessons of this war has been the immense value of railways. They form the backbone of transport in almost all countries, and have played a major part in nearly every land campaign.

Mr. Churchill, in his broadcast on 21st March, 1943, dealing with post-war problems, said: " We were first in the world with railways, we must bring them up-to-date *in every respect.*" Since air travel will eventually predominate for journeys over 200 miles or even less, the railway companies will mainly concentrate on improving complementary short-distance services. Light freight traffic may share the speeded-up passenger routes, as demonstrated by the streamlined diesel luggage-cars operating on the G.W.R. main lines in the London region. For heavier goods and mineral traffic, the trend towards providing separate exclusive tracks will increase, perhaps together with a more extensive use of canals.

Railway executives long ago recognised the economic value of speedy transit and quicker turn-rounds, but have only been able to practise them in minor degree, due to perpetuating legacies of obsolescent track-layouts, vehicle standards, build-

ings and equipment evolved during the past century, representing heavy capital investment, much of it no longer productive. However, the companies' financial positions have improved of late through the unprecedented traffic now being carried; this should be maintained for several years after hostilities cease, while people make up for the present lack of holidays and before the motor industry gets into its stride again. This condition should enable the railways to cut away much deadwood, and launch an extensive programme of modernisation; indeed, unless they do so, they will be subjected to an inexorable pressure of criticism from a public tending to use the aeroplane as the yardstick by which to measure contemporary land transport.

Civil aviation has already demonstrated the value of obtaining intensive service with a comparatively small number of vehicles operating at the highest speed technically practicable, in place of numerous slow-moving units operating at so-called "economic" speeds based on minimum fuel consumption. Rail speeds have increased annually by less than 1 per cent., but the corresponding rate for aircraft is about 8 per cent., with the result that far fewer machines are needed to maintain a service of given capacity than were required, say, twenty years ago. This is a prime factor in the profitable operation of air-lines, being second only to the outstanding advantage of great saving in journey time for the passenger, which justifies the higher fares charged. Obviously, railways cannot compete with aircraft in the matter of actual transit speed, but can nevertheless show considerable possibilities in this direction, as witness the 114 m.p.h. and more, attained by L.M.S. and L.N.E.R. trains drawn by streamlined steam locomotives or the remarkable *average* speed of 101 m.p.h. lately achieved on the sixty-mile run between Florence and Bologna, by a light streamlined electric train.

Equally important is a substantial reduction of waiting-time prior to the start of actual transit. To effect improvement, the train of orthodox length must be split up into shorter units operating at more frequent intervals; this tendency is reflected in the Southern Railway's present-day two-coach electric sets.

Ultimately, single cars on a minimum headway will form the basic service, with perhaps the addition of trailers, or coupling together to form two-car units and provide extra capacity in rush-hours, a policy already yielding excellent results on America's "Pacific Electric" railway, as mentioned elsewhere. Staggered working hours, as commendably advocated by London Transport, would be of great value in this direction. It is also worth bearing in mind that although all the employees in any factory, etc., may cease work at the same nominal time, they cannot all get through the exits simultaneously, and consequently never *arrive* at any adjacent transport boarding-point "en bloc," though this condition quickly obtains if the first-comers are not met and removed forthwith by the transporting medium. Single-car units operating closely can cope with peak

loads to a remarkable extent, while still retaining their flexibility and other advantages, as a comparison between London's Victoria Embankment tramway and the adjoining District Railway shows.

The need for costly and palatial railway stations can be eliminated. Present architectural planning to beautify existing ones is therefore misdirected, for they imply waiting, and wastage of time. A mere strip of paving is the ideal, with shelter but little more elaborate than the "beanstick" canopies now adorning many London suburban bus-stops. The other function of the orthodox station, that of collecting fares, would be more conveniently effected by a conductor on the vehicle, and his task simplified by a wider use of period, area and zone tickets.

For the more lightly-loaded routes, diesel-driven railcars, as pioneered by the G.W.R., will be increasingly used, but a possible alternative motive power might be producer gas, new applications of which are being energetically developed by Government-sporsored research. Wherever traffic density warrants provision of the necessary equipment, however, electricity is the obvious choice, offering very rapid acceleration, economy in power usage, instantaneous control, and freedom from fumes and smoke. The overhead-wire system ensures safety, continuous contact, easy maintenance, and absolute reliability under the severest weather conditions, hence its adoption for the electrification of the L.N.E.R. lines from Sheffield to Manchester, and from Liverpool Street to Shenfield, besides being almost exclusively favoured abroad. Automatic signalling and checking, well exemplified by London's underground lines, can be applied to an extent impossible with steerable road vehicles.

For convenience of access, the ideal high-speed railway would be disposed alongside or near main roads, and its coaches embody the lowest possible centre of gravity and load-line, in order to avoid excessive banking of track curves. This latter requirement necessitates small, compact motors, which in turn means making every coach a motor-coach, and harmonises with their operation either separately or coupled together as desired. Such tendencies show a trend towards the "light" railway, or tramway; thus the spiral of evolution turns full circle, since railways originated with the old mineral tramways.

An immediate and beneficial advance in this direction could be made by converting suitable railway branch-lines for operation by P.C.C.-type electric cars. These would be much faster than either diesel cars or road buses, and one-man operation as in America would ensure a degree of economy unobtainable by any other means, and permit a service sufficiently frequent to attract. Electrification for such light units could follow tramway practice; the smaller current-capacity required would mean much simpler and lighter switchgear, sub-station equipment, etc., while power might be obtained from the national grid. Promising instances would appear to be the single lines linking

Watford, St. Albans and Hatfield, at present served by unconnected intermittent steam trains. Joined to form one continuous route, by reserved-track street connections if necessary, extended south-westward via Rickmansworth, Denham, Uxbridge and Slough, to Staines, and south-eastward via Hertford, Epping and Brentwood to Tilbury, a new high-speed orbital artery would thus be created, which would greatly facilitate dispersal of light industries from the London area and attract new ones, besides developing the towns served as satellites to the Metropolis. Similar treatment of local railways forming the Norwich-Yarmouth-Lowestoft network would infuse new life and prosperity into agricultural Norfolk, and possibly lead to a redistribution of present dense Midland populations with resettlement under healthful maritime conditions.

Scope for similar local electrification exists among steam-powered " light " railways, such as the Kent and East Sussex, the Weston Clevedon and Portishead, and the Southwold-Halesworth lines. These might prove very good investment risks for new private enterprise, especially among aircraft or other light engineering firms seeking fresh fields for the post-war employment of their advanced technologies in the development of high-speed transport vehicles.

The Southern Railway has already set a magnificent example in its electrification of heavily-loaded main lines, and skilfully overcome the many technical difficulties presented by an immense intersecting network designed originally for steam operation on a much smaller scale. When the electrified service to Brighton was inaugurated in 1933, it was ushered in by a slogan: "You don't need a timetable!" which might be said to have heralded a new era in transport between separated cities. And when we call to mind the electric tramways outside Blackpool, Swansea and Grimsby, which run on ordinary railway tracks, it would appear that the railway and tramway are converging in development, and a stage will be reached in this country, as abroad, where they can join hands, and together provide unrivalled facilities for getting about quickly.

VII. Motorways.

The last thirty years have seen a stupendous growth of private transport by road, in the form of the owner-driven automobile. Its chief attribute is the provision of direct transport at will from door to door, or more commonly from front gate to car park. To enjoy this boon, however, the individual must (1) learn to drive; (2) purchase his vehicle either by capital expenditure or by a charge on his income; (3) provide for or pay for garaging; (4) pay tax and insurance; (5) pay running and repair costs; (6) undertake cleaning and maintenance; (7) expend physical and nervous energy in driving, and (8) pay for

minor extras such as parking charges, motorists' organisation membership fees, etc. The fact that possibly a majority of owner-drivers cannot properly afford to run their automobiles and only manage to do so by cutting down expenditure on their households or other essentials, has been responsible for certain social problems and tendencies, the examination of which is outside the scope of this booklet, except perhaps for the consideration that in general, where the automobile flourishes, the birth-rate tends to fall, and conversely that cheap public transport preponderates in the prolific countries, so that there may be some connection between transport and the important population question.

Stupendous energy has been put into the mass production of the automobile, and the "car for everyone" ideal vigorously propagated by the various trade interests profiting therefrom. Unfortunately, road development has not kept pace; motorists have a long-standing legitimate grievance in that they are heavily taxed under the promise of an adequate new road system, yet witness a large proportion of the money being expended by the Government in totally different directions, while existing roads are merely patched up. This, however, is not the fundamental reason for the huge volume of accidents commonly known as the "Toll of the Road." So long as we accept the principle that virtually every man is entitled to steer his own vehicle along the public highway, then we must also accept the consequential results, inevitable with the innumerable shades of skill and temperament to be found amongst millions of individual drivers, each possessing his own mental make-up.

The war, however, has demonstrated that the nation's life can be carried on with but a small fraction of such private transport; what ever re-expansion takes place when peace returns, true economy will demand the maximum usage and development of public transport services, since these can carry people at one fifth of the cost, while utilising only from one-fifth to one-eighth of the road space. This is of particular importance in urban areas, in order to avoid spreading them with great wastage of land, or alternatively suffering great road-congestion, such as prevailed on fine Sundays in 1939, when a mere 50 per cent. increase in vehicles would have brought to a paralysing standstill all traffic on many arterial highways. Equally serious, but insufficiently appreciated, is the problem of automobile parking at business premises and factories. At one aircraft works in N.W. London, only six executives regularly parked their cars in the works yard during 1930. Four years later the number had risen to 30 cars. By 1937 there were 150, and the firm had to rent an adjacent piece of waste ground for a car-park. By 1939 there were nearly 400; they overflowed into adjoining streets, and prosecutions for obstruction took place almost daily. Those people early enough to get places inside the car-park in the morning, found that it took them

anything up to half-an-hour to get their cars out again in the evening.

However, it will be futile to attempt to *force* private motorists off the road, even in dense urban areas, if the alternative public services are slow, inconvenient and costly, as across Outer London. Where such conditions prevail, mere appeals by the public transport operating authority for a "square deal," or discreet attempts to legally restrict motoring, are worse than useless; they invite damaging comparisons which breed determined antagonism and organised opposition. Passengers can only be *attracted* away from automobiles, by providing services which outweigh in combination of attributes, and since safety and cheapness are usually on the side of public transport, the criterion tends to be door-to-door speed, of which the component factors are (1) accessibility; (2) service frequency; (3) all-weather regularity, and (4) average running-speed.

Accessibility requires a close network of services, to give proximity to individual homes. Few people object to a *short* walk to reach their transport service; indeed, the medical profession strongly recommends such mild exercise. It is the wait at the boarding point which is universally detested, not merely as a tiresome waste of time, but also as one of the most common causes of colds, bad circulation, etc. From the psychological point of view, frequency of service is of great importance to the prospective passenger; the operator must therefore consider which type of vehicle is cheapest and most profitable on a short headway. He must also consider which type possesses an overload capacity sufficient to cater for sudden increases in load due to adverse weather changes or other unpredictable causes, and which can maintain the highest degree of regularity under such variable conditions. And in order to ensure a high average speed over the comparatively short distances obtaining on urban routes, rapid acceleration and braking must be possible with reasonable economy in power consumption and a minimum of wear and tear.

Clearly, then, if the motorist is to be attracted towards public transport, a radical change in outlook is necessary, together with an open mind capable of discarding old prejudices. Such a spirit animated the American tramway "Presidents' Conference Committee," introducing technical developments in 1935 which have not only scored a resounding triumph over the best that contemporary bus design can offer, but have done so in a country where automobiles are normally universal, and petrol cheaper than anywhere else in the world. The P.C.C. tram is the embodiment of modern engineering science, and fulfils with brilliant success the requirements of its sponsors and operators. It is interesting to note that even at the peak of automobile usage in the United States, i.e., at the time of that country's entry into the war, well over 50 per cent. of her short-distance public-transport passengers were carried by tram. Since 1941, this percentage has increased considerably.

In rural areas, conditions are different. Room exists to build new trunk roads—the proposed " motorways." These, however, may speed up traffic, but will not necessarily be safe. Dense traffic moving at high speed presents many problems not encountered at low speed. The slightest miscalculation in driving, or the smallest skid, which would scarcely be felt at 20 m.p.h., and cause nothing more than a jolt at 40 m.p.h., will be fraught with danger at 60 m.p.h., and result in a spectacular fatal accident at 80 m.p.h. One can speed up the machine, but not the rapidity of human judgement. The inescapable truth is that there are fundamental speed limitations inherent with steerable vehicles on highways of fixed width. It is true that the world's speed record for automobiles stands at over 300 m.p.h. but this was achieved only on Daytona Beach, not exactly a public thoroughfare.

Certainly the new motorways will not be *intended* as mere spectacular race-tracks, even if they so degenerate through unrestrained competition between motor-manufacturers aiming to provide the most dazzling " performance " for their own particular products. If the true purpose of these roads is to enable large numbers if people to journey quickly, it is unwise to propose the exclusion of public transport vehicles, with their inherent economies in cost and capacity. Admittedly, motor- and trolley-buses, restricted to 30 m.p.h. for safety reasons even on wide arterial roads, can never hope to offer the same time-saving as automobiles travelling at up to 70 m.p.h. with door-to-door convenience. The pre-war " Green Line " coach services, averaging about 20 m.p.h. including limited stops, would seem to represent the approximate limit for fast bus operation.

It is said that on the proposed motorways, vehicles will be segregated in traffic-lanes. White lines may separate them, but cannot enforce adherence. Physical boundaries such as railings or parapets will reduce clearances and impose an intolerable strain on drivers, unless each traffic-lane be made of great width; their sum total will then result in not so much a road as a huge estuary of concrete, and will cost accordingly. It is worth noting that almost all road improvements, such as traffic signals, flyovers, pedestrian subways and bridges, bus stations, traffic-lanes and dual-carriageways for " up " and " down " traffic, belatedly follow railway practice, except in the one condition essential for 100 per cent. success, which is the enforced adherence to a pre-determined path, mechanically implicit in the use of rails. The provision of these, however, is obviously impracticable for countless small private automobiles.

So long as their traffic is not heavy, the proposed motorways will serve well, but it is essential to provide a margin for future overloading. This can best be done by making 20 feet wide the strip separating the dual carriageways. For eventually, the complement to the ubiquitous mass-produced automobile must be a public transport vehicle capable of considerably higher

speeds with perfect safety, dependent on the physical characteristics of any route and the frequency of its stops, but ranging up to 120 m.p.h. or so wherever possible, for which extremely rapid acceleration, simplicity of control and perfect braking are essential. And as requisite speed increases, a point will be reached where it will be found actually cheaper in *first cost* to lay a rail-track on the central reservation instead of providing special traffic-lanes sufficiently wide to permit the safe operation of high-speed buses. Only rails can guarantee adherence in all weathers and at all speeds, to a traffic-lane barely wider than the vehicles using it. Furthermore, comfort to the point of luxury, a complete absence of fumes and vibration, together with reasonably low fare-levels, will be prime essentials. So in a few years' time, when operators of inter-urban buses face the problem of providing new equipment capable of attaining the high speeds which will be demanded by younger generations growing to maturity with the transport aeroplane, they may find their answer in the electric high-speed light-railway, or reserved-track tramway.

In densely-populated Britain, the provision of electrical energy for traction purposes over wide areas has been greatly facilitated by the institution of the national " grid " and development of the static rectifier type of sub-station. National interests will be promoted far more by the economical use of a home-produced fuel instead of a comparatively wasteful misuse of imported petrol, particularly since the latter product is indisputably necessary for aviation and distributive commercial motor-transport. Moreover, since coal is our only exportable raw material, besides being the source of almost all our industrial power, it is unlikely to be available in quantity for the manufacture of synthetic petrol, especially in view of the higher cost of this product by comparison with the natural fuel.

Mr. Noel-Baker was recently reported as saying that within the next twenty years there will be four times the number of cars on the road that there were in 1939. How far circumstances, particularly the development of small owner-piloted aircraft, will influence such an expansion, can only be revealed in the fulness of time, but his forecast implies a serious position for most public transport authorities, and they must eventually reorient their policies if they are to survive. The war has given them almost the whole of Britain's passenger traffic. They will have a flying start when peace comes, not only to expand and improve their services to the uttermost, but also to consolidate in the public mind the advantages of public transport over the responsibilities inherent with a private automobile. In such post-war developments, tramways can, and should, play a useful and profitable part. Hitherto, their characteristic rail-tracks have been economically justified or condemned from the standpoint of load. The second great attribute of rails, that of providing precise automatic steering at all speeds, has yet to be fully

PLATE X.

FOUR VIEWS OF ABERDEEN'S LATEST STREAMLINED BOGIE CAR, showing (1) exterior view; (2) Motorman's cab from inside; (3) and (4) Interior of lower and upper passenger saloons.

[*Block courtesy Modern Transport.*

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[*Photos.* "*Transport World.*"

A Contrast in High-capacity Electric Cars.—Above, luxury streamlined single-deck car in the streets of Moscow, Russia; below, 106-seater double-deck car as used on the Swansea and Mumbles Railway, South Wales. The latter line is the oldest railway in the world still independently operated, having obtained its powers in 1804. These giant cars are coupled in trains of two or more at busy times.

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exploited. In the future age of ultra-high speed, when aircraft may render obsolete road-tied vehicles of limited mobility, the fast rail vehicle will assuredly come into its own.

VIII. Modern Tramways Reviewed.

The electric tram is only at the beginning of its development, in spite of difficulties in the past, most of which have been due to one or more of the following causes:

(1) Insufficient passenger traffic to justify original outlay or renewal of fixed equipment.

(2) Unsuitable disposition of routes; mainly through some streets traversed being too narrow for their total vehicular traffic.

(3) Primitive and immature technical development, crystallised by long life of vehicles during contemporary changing standards.

(4) Obsolete bye-laws and unfair legislation.

(5) Municipal enterprise cramped by ill-informed ratepayers.

(6) Severe bus competition under unfavourable conditions.

(7) Hostile propaganda instigated by competing sectional trade interests, particularly when afforded any justification through items (1) to (5).

But if the difficulties have been great, so also have been the achievements. Glasgow's tramway system is world-famous for its bright colourful efficiency—and its 3d. maximum fare. The "Coronation" type bogie trams introduced in 1937 are reputed to be the most comfortable short-stage vehicles in Europe. Iiverpool opens a new extension every few months, mostly reserved track, of which the undertaking now possesses more than 20 miles in addition to its extensive street network. Several hundred modern streamlined trams, and extremely cheap fares, help to give an excellent service, highly praised by Mr. Bevin, Minister of Labour, for its ability to cope with the city's huge influx of war-workers. Leeds and Sheffield vie with one another in good smartly-operated tramway services at very low fares. The former city is famed for its ultra-modern track reservations, the latter for its extraordinary ability to handle heavy street loads under very adverse conditions; both undertakings operate many fine modern cars, well-liked by shrewd Yorkshire people, and are planning post-war extensions. Sunderland's smaller compact system is aptly termed the "Pocket Hercules" and furnishes a magnificent example of what common sense and ability can accomplish in a comparatively small town.

Blackpool's streamliners are world-famous, and in keeping with the local go-ahead spirit, which recently caused the town to be the first in the country to apply for powers to operate municipal air-services. Edinburgh and Dundee both exemplify sound, useful and prosperous tramway development. Aberdeen put into service during 1940 new trams of a very advanced type,

mechanical defects:—Motor-buses: 2.47; Trolley-buses: 3.43; Trams. 1.81, per 10,000 vehicle miles run in each case. And whereas this city's trolley-buses are modern, its trams certainly are not. Another city's transport manager, with considerable previous trolley-bus experience, who was called upon to report to his local transport committee on the desirability or otherwise of converting the local tram routes, stated that an extra 5 per cent. of trolley-buses (or 10 per cent. in the case of motor-buses) would be necessary on this score alone, irrespective of overload capacity. This city wisely kept its tramways, and by judicious modernisation, reduced their overall operating costs by 22 per cent. while greatly improving the services. From Melbourne comes the report that during 1942-3 its trams developed only one-fifth the number of defects by comparison with its buses, on a basis of equal mileage run.

(3) Longer vehicle life, due to lack of road-bumping and vibration.

Motor-buses: 8 to 14 years.

Trolley-buses: 12 to 18 years.

Trams: 20 to 40 years. Some of London's "E/1" type trams are still giving useful service after 35 years; they have each covered more than a million miles.

NOTE: Items (1) to (3) in combination explain why trams generally operate at lower fare-levels than trolley-buses.

(4) Quicker acceleration.

Owing to the ease with which all axles can be made to propel, together with straight-line motion (no pulling-out). America's P.C.C. trams accelerate at 4 to 5 m.p.h. per second; i.e., nearly 50 per cent. faster than the present London trolley-buses.

(5) Less obstructive on wide streets.

Trams are compelled by their rails to keep in line, and cannot "cut-in" on other vehicles, or block their paths by swerving towards or away from kerbs. Bus flexibility is unnecessary and obstructive on modern well-planned streets, fifty feet and more in kerb-to-kerb width, which allow a heavy volume of traffic to flow without congestion. Trams discipline or marshall other traffic; they do not yield to reckless drivers, neither do they penalise careful ones.

(6) Much higher potential speeds.

The fundamental limitation inherent with large steerable vehicles is reflected by their 30 m.p.h. limit, applying even on wide arterial roads. Trams possess automatic steering, and require only the same width of road for any speed, whether 12 m.p.h. or 120 m.p.h. On reserved tracks or through subways, railway speeds are easily attained with complete safety. In many American cities, trams operate at 20 to 30 m.p.h. through central streets, but at 50 to 80 m.p.h. on reserved tracks in suburbs and between towns.

On the Chicago "North Shore" inter-urban tramway, some stretches are covered at an average speed of 75 m.p.h. start-to-stop. On such runs, 90 m.p.h. is attained regularly, and 100 m.p.h. occasionally. Electric railcars have exceeded 130 m.p.h.; only aircraft can provide faster transport!

(7) Ease and simplicity of control.
No steering. One control-handle only for power; on some systems, including London, this same handle instantaneously applies powerful non-skid brakes when moved in the reverse direction. Drivers suffer far less from strain particularly at high speeds or in busy streets. During war-time or any other emergency, untrained personnel or women can drive trams far more easily than buses. Certain French and other continental towns employ women drivers in peace-time for this purpose. Operation on "Pay as You Enter" system is facilitated.

(8) Superior for subway operation.
Automatic steering necessitates only small side-clearances, irrespective of speed, and allows any tram-subway to be constructed to a minimum width. Current-collection by conduit, third rail, or by overhead-wire using bows or pantographs can be employed, where the use of ordinary trolley-booms would entail frequent dewirements. Automatic signalling and stopping devices can be utilised much more easily, if so desired. London's Kingsway tram subway has carried approximately 300 million passengers with a remarkable accident-free record.

(9) Guaranteed unrestricted kerbside parking for motor traffic.
Even light bus-services may neutralise 15 per cent. of available kerbside space, by requiring to pull in and out at stops. Heavy bus-services may neutralise up to 100 per cent. of kerb, as in Oxford Street, Cheapside or Strand, London. Trams leave kerb space free for automobiles and commercial delivery vans, for which parking is absolutely essential.

(10) Greatest safety for pedestrians, passengers, and other road-users.
Accident statistics of practically all cities and towns operating trams, in Britain, in the United States, on the Continent and elsewhere, show the tram to be indisputably the safest road transport vehicle. Trams cannot skid, no matter what the condition of the road surface. They are compelled by law to carry efficient lifeguard fenders, and have extremely powerful quick-acting brakes which operate on the rails as well as the wheels. Pedestrians, cyclists and motorists can easily see where the tram runs and can avoid it without difficulty. Some small tramway systems have never had a fatal accident; at Southend, 510,000,000 passengers were carried during 41 years without a single fatality. London statistics for 1942 show trolley-buses to be well over 50 per

cent more lethal than the trams. Impatient motorists sometimes criticise the presence of tram-rails, but actual statistics show that accidents due to them are negligible. The unyielding tram encourages carefulness on the part of other road-users. On reserved-track tramways, accidents are almost unknown.

NOTE: Items (4) to (10) emphasise the extreme value and importance of tramways in planning future road sytems.

(11) Greater all-weather reliability.
Trams can still maintain a service in fog intense enough to immobilise all other traffic. Some years ago, the "Evening News" reported Lord Ashfield as stating that of all forms of surface transport, the L.C.C. tramways were the least affected by fog. Another advantage shows in very cold weather, when roads may become iced over, and rendered unsuitable for buses and automobiles. Hence the great use and popularity of tramways in Canada and Russia.

(12) Greater overload capacity.
Its symmetrical and balanced form of structure, together with the firm basic platform afforded by steel wheels on steel rails, makes possible for trams a degree of overloading far greater than with rubber-tyred vehicles. This proves of the utmost value in sudden inclement weather, dispersal of crowds, or other unexpected emergencies. Blackpool, with 30 per cent of its trams not in regular use through shortage of crews, has yet managed successfully to cope with a huge influx of evacuated civil servants; in 1942 the remaining 70 per cent. carried 76,000,000 passengers, double the heavy pre-war load of 38,000,000 carried in 1939. During the London bus strike of 1937, the trams succeeded in absorbing almost the whole of the load that would have been carried by the central buses, greatly augmented though it was by innumerable Coronation visitors, and in spite of the fact that owing to trade-union agreements no extra trams were run! The manager of one flourishing provincial tramway system estimates that at least 20 per cent. more trolley-buses than trams would be required to provide the same overload capacity in his town, for an equal seating capacity. Such extra consumption (see item 1) would necessitate the provision of additional generators, sub-stations and feeder-cables. (This has actually proved to be the case in London and elsewhere.) In certain northern towns which have suffered from considerable curtailments of bus-services, their bogie trams sometimes carry as many as 130 passengers.

(13) Ability to operate cars coupled together.
A further useful means of increasing capacity. On the Continent, trailer-cars are almost universal. During the last war the L.C.C. tramways employed them with great benefit, on routes 2 and 4 (Embankment-Merton), route 44

(Woolwich-Eltham) and elsewhere. In St. Louis, Los Angeles and many other American cities, suitably-equipped trams operate singly or coupled into multiple-unit sets. This is also done on Britain's Swansea-Mumbles electric line, using double-deck cars. Oakland (Calif.), Brooklyn and Calcutta operate two-car articulated trams.

(14) Easy reversing without loops or turning-circles.
This is of great value at busy city termini, such as Southwark Bridge and Victoria, London. Moreover, cars can be turned back quickly at suitable points according to varying traffic requirements, without hindering other road-vehicles. Almost all the London trolley-bus terminal points involve extra walking for passengers, as at Paddington Green and Finsbury Square, or else congestive looping as at Holborn and Liverpool Street Station, or appreciable "dead" mileage as at Tottenham Court Road and Walm Lane, Cricklewood.

(15) Potentially greater comfort.
The smoothest road is bumpy compared with level steel rails, and straight-line motion is better than one which involves frequent swerving in and out. These considerations, together with modern seating and upholstery, make the *modern* tram the steadiest and most comfortable vehicle on the road. Good examples are to be found at Blackpool, Glasgow, Leeds, Liverpool, Sheffield, Sunderland, Aberdeen, etc. All too often are modern buses compared with trams 30 years older, to the obvious disadvantage of the latter. America's P.C.C. trams are dubbed "Glideaways" because of their perfect motion, imperceptible even at 50 m.p.h. Cleveland's citizens recently voted 30 to 1 in their favour and against buses.

(16) Benefit to local rates, etc.
Whereas buses pay tax for their use of the common highway, trams provide and maintain their own road in the form of their steel track. This takes their load off the carriageways. But in addition, trams have to maintain the roadway between their rails and for eighteen inches on either side, although they do not wear it down themselves. And they have to pay rates on their installations, based on revenue and expenditure. Trams are thereby penalised unfairly, but nevertheless are a source of considerable financial benefit to the *local* authorities through whose districts their routes pass. Bus taxation goes to swell the Road Fund, which is periodically pruned to help balance the Budget!

(17) Value for auxiliary goods services.
Many tramway systems in Canada and the U.S. are linked with the main-line railways, and operate standard freight-cars with their own electric locomotives. German towns use their tramways extensively for the distribution of coal,

vegetables, parcels and military equipment, also for the removal of earth excavated in the construction of air-raid shelters. The Russians make similar use of their trams, and in some cities operate special night services for conveying material to factories, returning with loads of manufactured articles.

Some years ago, when snow and ice rendered roads in the Leeds area impassable to motor traffic, the reserved-track tramway to Middleton became the sole link between that village and the city, and was used to convey food and other necessities to the local inhabitants.

(18) Use of home-produced steel, instead of imported rubber.
The value of this needs no further emphasis at present! After the war, many other industries besides tyre-manufacturing will also need rubber, and complementary usage of steel will help to balance our frugal post-war national economy.

(19) Less elaborate and unsightly overhead wiring.
The use of bow-collectors and pantographs results in a general simplification of tramway wiring, by eliminating the use of moving frogs and actuating wires at junctions. By contrast, trolley-bus junctions frequently require the installation of pre-selective or advanced frogs and extra by-pass wires at from 40 to 100 yards before the point of intersection, in order to eliminate " deads." On broad dual-carriageway roads, a tramway reservation along the middle requires only single central standards to support both wires. On similar roads trolley-buses require central and flanking standards, i.e., three standards to support the four wires, as exemplified by the dual-carriageway portions of the Uxbridge Road at Hanwell, Southall and Hayes (Middlesex). The " conduit " system for tramways eliminates all overhead wiring.

(20) Vehicles electrically " earthed " at all times.
Faulty or inadequate insulation of the main power-circuits causes a leakage of current into the body of the vehicle, which possesses considerable electrical capacity in its metal structure and panelling. When this occurs, a powerful charge builds up, with dangerous consequences for passengers and depot staffs, unless, of course, continuous earthing is provided. Trolley-buses, being insulated from the road by their rubber tyres, need frequent careful inspection for safety. Trouble of this nature has been reported from Manchester, Newcastle and elsewhere, and is likely to increase as vehicles age, owing to deterioration of cables and insulation.

The foregoing items serve to elucidate an important fact, viz.: that while the trolley-bus may be an excellent substitute for the motor-bus on certain moderately-busy routes, it is seldom in the long run found to be a satisfactory substitute for the modern

THE TRANSPORT OF THE FUTURE.—A Leeds Corporation luxury car running through pretty woodland scenery en route to Middleton. Delays are impossible on this private "express" track.

[*Photo: Leeds City Transport.*

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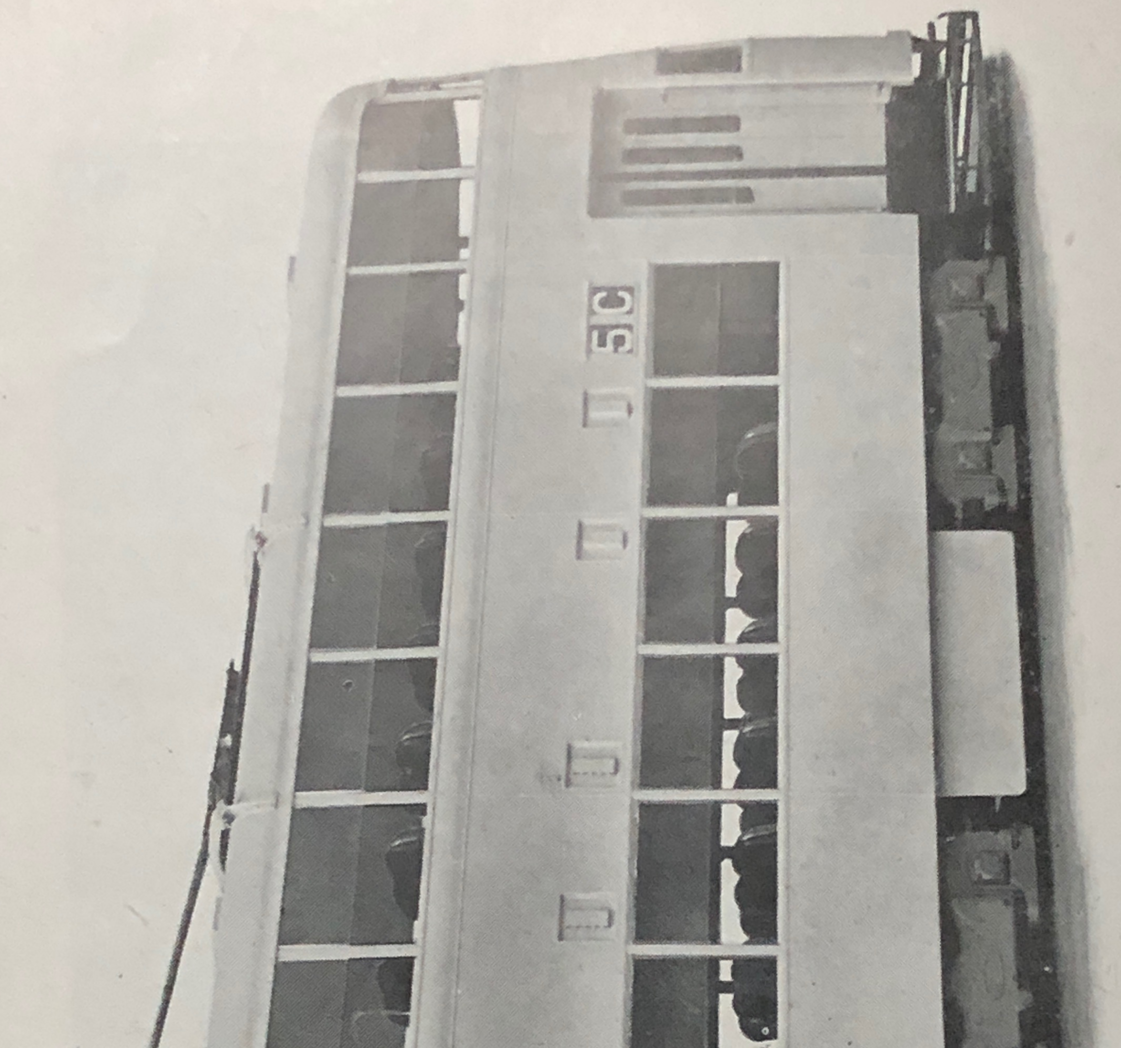

SOUTH AFRICA GOES MODERN.—74-seater double-deck car, on Maley & Taunton trucks, at Johannesburg.

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tram. British electrical manufacturers may find that a study of these implications will point a way to profitable expansions of business, by a widening of the field for their products.

(B) BY COMPARISON WITH MOTOR-BUSES.

NOTE: All of the foregoing items apply to motor-buses as well as trolley-buses, excepting Nos. (19) and (20). Most of the items apply in even greater measure.

(21) No poisonous fumes and odours.

One single motor-bus emits thousands of cubic feet of poisonous exhaust fumes during a day's running. This is not merely objectionable but detrimental to health, and is very noticeable in busy central streets carrying dense bus traffic, such as Strand, Piccadilly, Oxford Street, Cheapside, etc. The superiority of electric traction in this respect was praised by the "Automobile Engineer" for 4th November, 1943, which condemned motor-buses as "dirty, noisy and evil-smelling anachronisms, which should be prohibited from city streets and congested traffic-areas." This journal commendably suggests legislation by the Ministry of Fuel and Power to make all short-distance transport electric.

(22) Less noise and no vibration.

The modern tram, with its smooth even movement and rotary motors, is adequately quiet without being dangerously silent. Motor-buses, with their reciprocating pistons, diesel knock, and necessary gear-boxes, emit considerable noise, especially when starting-up or climbing hills.

(23) Simpler operation of power-driven auxiliaries.

Ample electrical energy readily available for actuating brakes, doors, "trafficators," mechanical ventilation, sliding sun-roofs, etc. Also available for really adequate interior-lighting.

(24) Use of home-produced electricity instead of imported fuels.

This is amply evident at the present time. After the war, great expansions of civil aviation, increased commercial motor-transport and the revival of private motoring, will greatly increase the demand for petrol and oil-fuels, the importation of which must be a heavy adverse factor in balancing our trade budgets.

(25) Cheaper electricity for local users.

A tramway power-load may improve the load-factor at a local generating-station, thereby making possible lower charges for domestic electricity supplies in the district.

Advantages other than those listed may appear from time to time. One of the minor surprises of the war is the rapidity with which it has been found possible to restore any form of rail service dislocated by enemy bombing. On several occasions

in London, heavy bombs have fallen in the middle of main thoroughfares and destroyed the tram tracks, in each case making a huge crater extending the full width of the road. However, it was frequently found possible quickly to erect temporary bridging structure capable of supporting tram-rails, and to restore the service within a few hours, while the lengthy and complicated work of repairing electric, water and gas mains, telephone cables, sewers, etc., was carried out unhindered below. Other road traffic had frequently to be diverted until such repair work was finished and the crater filled in. Birmingham has made extensive use of temporary portable ramp-rails, short portions of which can be installed in a few minutes to bridge fire-hoses, etc. One universal feature of main streets after bombing is the huge quantities of broken glass from windows strewn in the roadway, causing serious damage to the rubber tyres of buses and other motor vehicles, but presenting no difficulty to trams.

(C) BY COMPARISON WITH ELECTRIC SUBURBAN RAILWAYS.

(26) Greatly reduced capital outlay.

This is due to the following characteristics:—

- (a) No elaborate stations, booking offices, waiting rooms or long platforms. Tramways need only loading-islands or short strips of paving.
- (b) Little or no heavy engineering work, such as cuttings and embankments.
- (c) Tunnels, if required, can be of lighter construction.
- (d) Simpler and lighter electrical equipment, due to smaller, more uniform loading per section.
- (e) Little or no signalling equipment.

(27) Much more frequent services for the same capacity.

A tram every 5 minutes instead of a six-car train every half-hour, and *pro rata*. A few years ago, America's "Pacific Electric" system operated one of its long inter-urban routes with a three-car train every hour, and suffered severe competition both from buses and from private automobiles. Then the company split up the train and operated single cars every 20 minutes instead. Within a few months passenger loads doubled. Thereupon the "P.E." increased the service to a car every 15 minutes, and found it patronised still more. Now, *two-car* units are operated every ten minutes, and business is exceedingly good!

(28) Greatly reduced volume of noise.

Modern design of motors and gears makes possible much quieter running for all electric vehicles, but the single-car or two-car tramway unit will never produce the same volume of noise as a six-car or eight-car train. Moreover, the tram's lower body panels result in its motors being more fully enclosed.

(29) Simpler disposition of routes.
By virtue of their shorter length and quicker response to controls, trams can, where necessary, negotiate curves of much smaller radius than is possible with ordinary railway vehicles. Gradients, too, can be very much steeper.

(30) Improved acessibility.
Tramways follow roads, which form natural feeders to them, and give direct access without wasting time through pre-booking, ticket inspection, and collection at barriers. In any emergency, passengers can easily alight.

(31) More flexible in operation.
Trams can be quickly reversed at intermediate points, can follow one another closely, and draw right up to one another at stops.

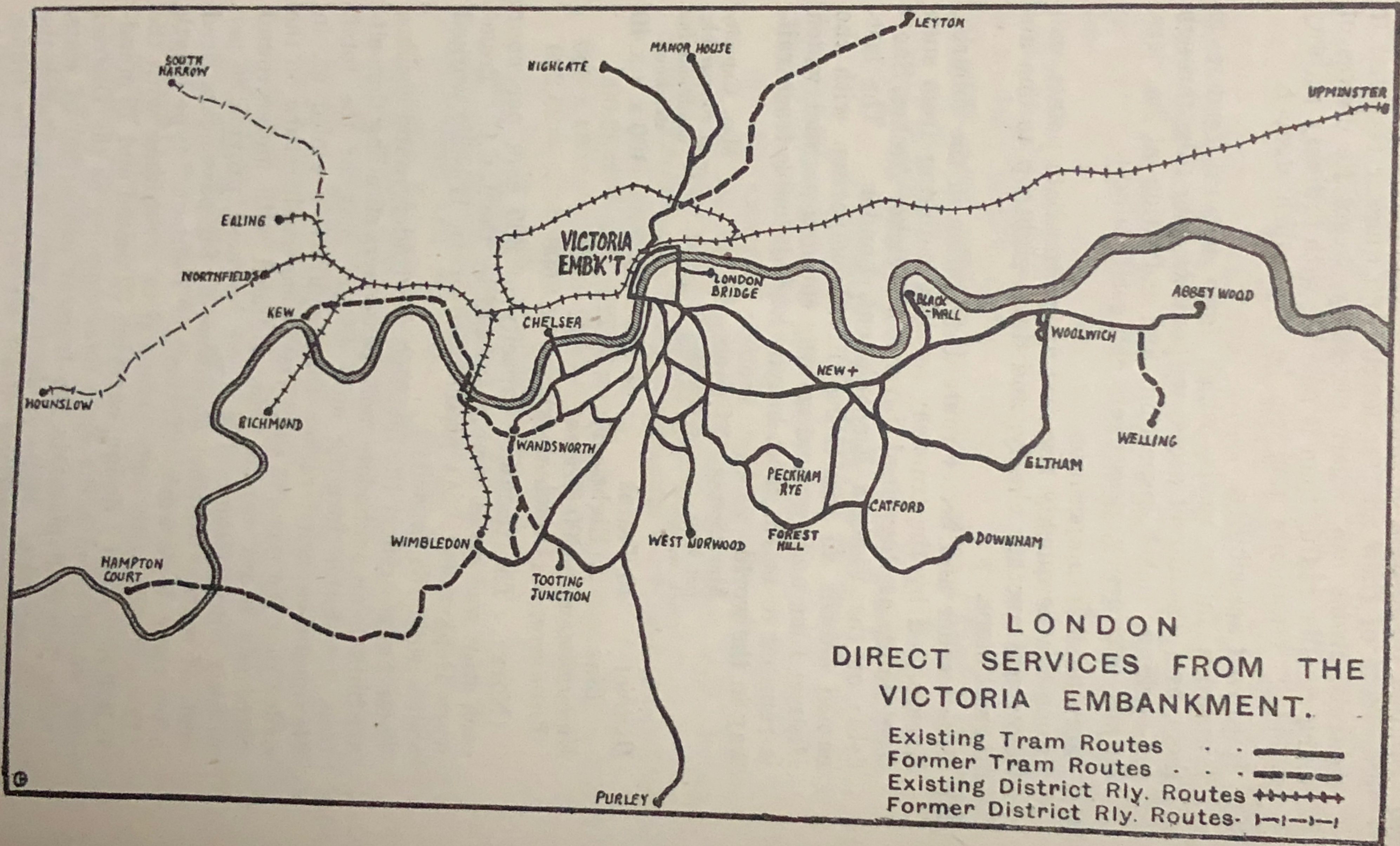
(32) Much wider and better route distribution in the suburbs.
Exemplified by the tramway services radiating from such focal points as Pier Head, Liverpool; Wicker Arches, Sheffield; or the Victoria Embankment, London. The last-named affords an interesting direct comparison with the District Line underground railway running parallel, which is reputed to be the most heavily-loaded double-track railway in the world.

	Max. Service per hour (each way)	Capacity Average No. of seats per hour	Max. Capacity with comparable conditions for standing.
District Line	40 Trains (Eight-car)	46 x 8 x 40 =14,720	100 x 8 x 40 =32,000
Embankment Tramway.	300 Trams (Double-deck)	72 x 300 =21,600	84 x 300 =25,200

(NOTE: The tramway capacity of 300 cars per hour each way was given some years ago by the L.C.C. Tramways Department. At present the service is being worked well within this capacity.)

These figures reflect the fact that the Underground coaches are built to accommodate more passengers standing than sitting, the latter forming only 46 per cent. of the total. Maximum capacity rather than comfort is aimed at, in order that the receipts shall yield some small return on the extremely heavy capital costs entailed with underground railway construction. The trams, however, provide 86 per cent. of seats, a distinct improvement for passengers tired after their day's work. Trams of " Feltham " type length (42 feet), but with seats arranged in accordance with the L.R.T.L. " Ideal " design, carrying 92 seated and 15 standing, would furnish the same total capacity as the District trains, but still maintain the tramcar proportion of seats, i.e., 86 per cent. Maps of the two systems emphasise the far wider area receiving direct services with the trams, which yet manage to give a frequent headway on all routes.

The capital outlay per mile for constructing this tram-


LEYTON
MANOR HOUSE
HIGHGATE
SOUTH HARROW
UPMINSTER
EALING
VICTORIA EMBK'T
NORTHFIELDS
LONDON BRIDGE
BLACK-WALL
ABBEY WOOD
KEW
CHELSEA
WOOLWICH
NEW +
HOUNSLOW
RICHMOND
WANDSWORTH
WELLING
ELTHAM
PECKHAM RYE
CATFORD
WIMBLEDON
WEST NORWOOD
FOREST HILL
DOWNHAM
HAMPTON COURT
TOOTING JUNCTION
PURLEY
LONDON
DIRECT SERVICES FROM THE
VICTORIA EMBANKMENT.
Existing Tram Routes
Former Tram Routes
Existing District Rly. Routes
Former District Rly. Routes

way was less than one-tenth that for the underground railway. An even greater disparity is evident when compared with deep-level or "tube" railways, the extensive construction of which is frequently advocated as a solution of urban transport problems, particularly in the London area. Some years ago Lord Ashfield, then chairman of the Underground group of companies, stated that a mile of tube-railway, including rolling-stock, cost £850,000 whereas the same length of tramway cost only £50,000. Clearly, then, the enormous capital costs of the former can only be justified when the districts under which its tunnels lie offer no possibilities of reconstruction. Moreover, the tube railway requires expensive *secondary* transport to reach it, in the form of escalators or lifts, whereas the twin electrified tracks of the tramway are easily accessible. For the dense passenger traffic of the compact city, tube railways are a palliative, but modern tramways are the real remedy.

Contents.

List of Illustrations.

Line Drawings.

This book is published by the

Light Railway Transport League,

a body of professional and lay persons interested in the development of transport facilities on sane and healthy lines. If you have found it interesting, you would probably also like the League's other publications, which include an illustrated monthly magazine THE MODERN TRAMWAY, a book with many illustrations and maps entitled GREAT BRITISH TRAMWAY NETWORKS and an explanatory booklet 50 QUESTIONS AND ANSWERS ABOUT TRAMS.

★

If you are in sympathy with the reforms recommended, you should consider supporting the work of the League by membership. Particulars regarding all these matters will be gladly supplied upon application to:—

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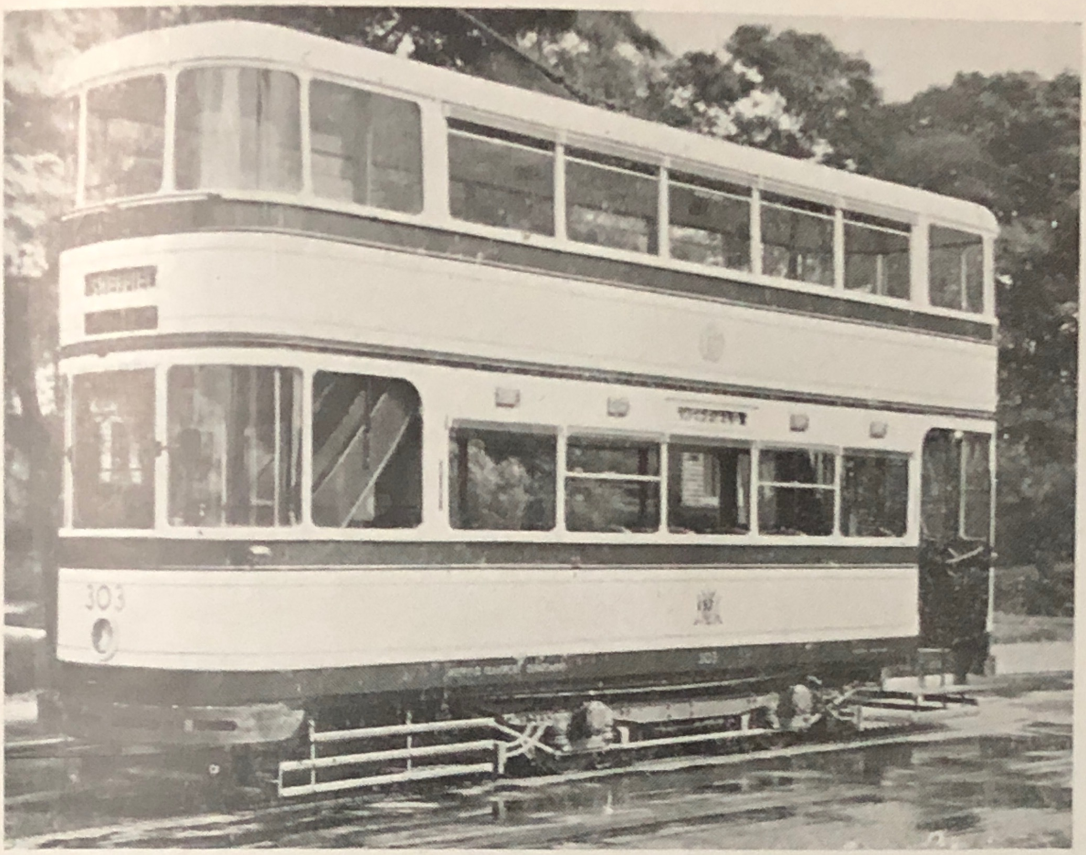
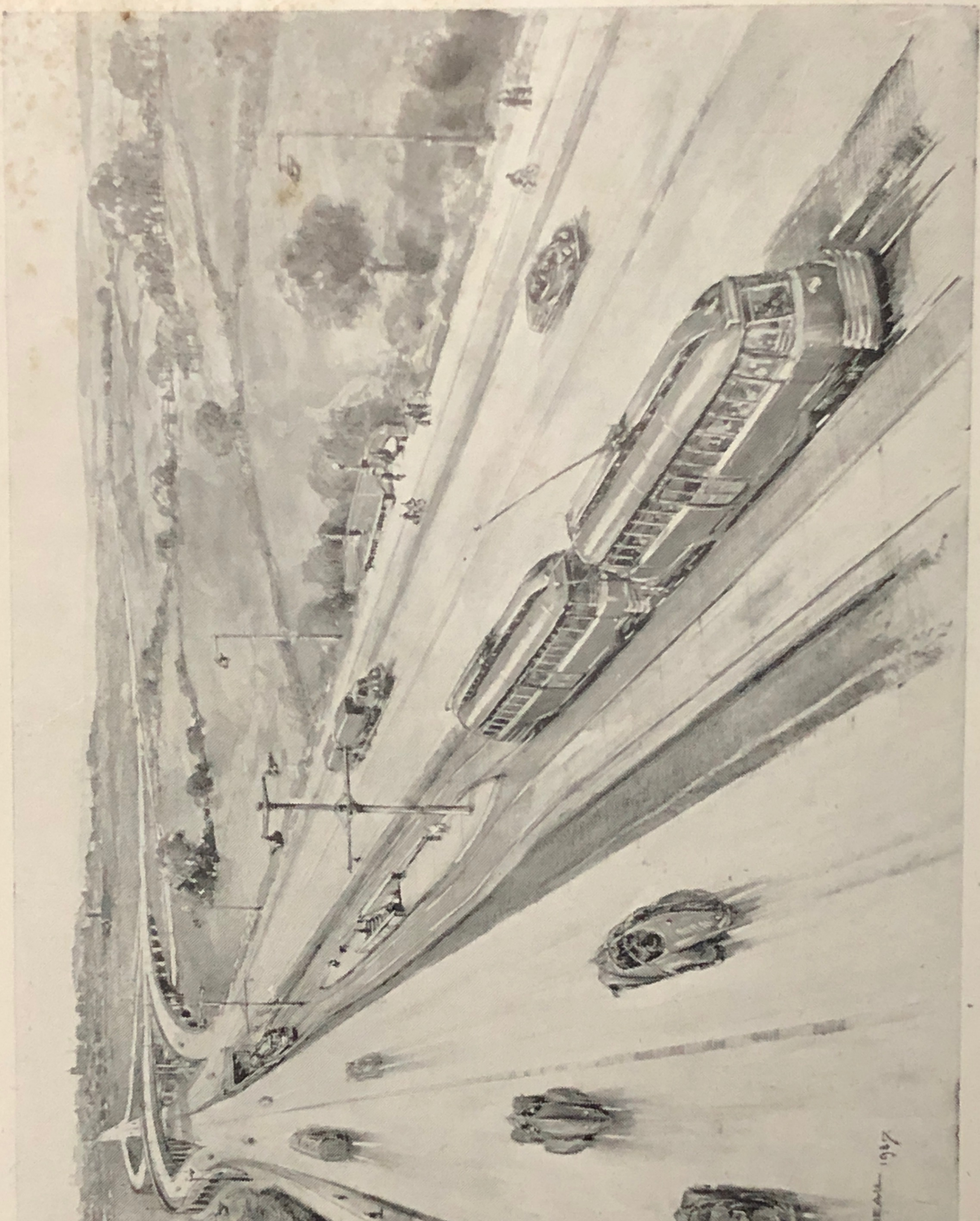
PLATE XIV.



[*Photo: Sheffield Corporation Transport Dept.*

[*Photo English Electric Co., Ltd.*

Modern Tramcars in Yorkshire Twin Towns.—Above, an attractive car of Sheffield Corporation Transport Dept. Note the clean and business-like lines of the car body. Below, one of the unique single-ended cars of Rotherham Corporation, which run on the joint through service to Sheffield. The erection of trolley-bus wires to the Sheffield boundary to give through services from the other side of Rotherham proved an expensive failure, as passengers preferred to change to the tramcars for their extra comfort.



An impression of modern arterial road development, from a drawing prepared by the well-known artist Bryan de Grineau, showing the use of fast reserved-track tramways, clover-leaf road junctions, and avoiding subways for the rail tracks. Thus the heavy passenger movement is segregated in a safety lane, and the ordinary carriageways left free for motor traffic.

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